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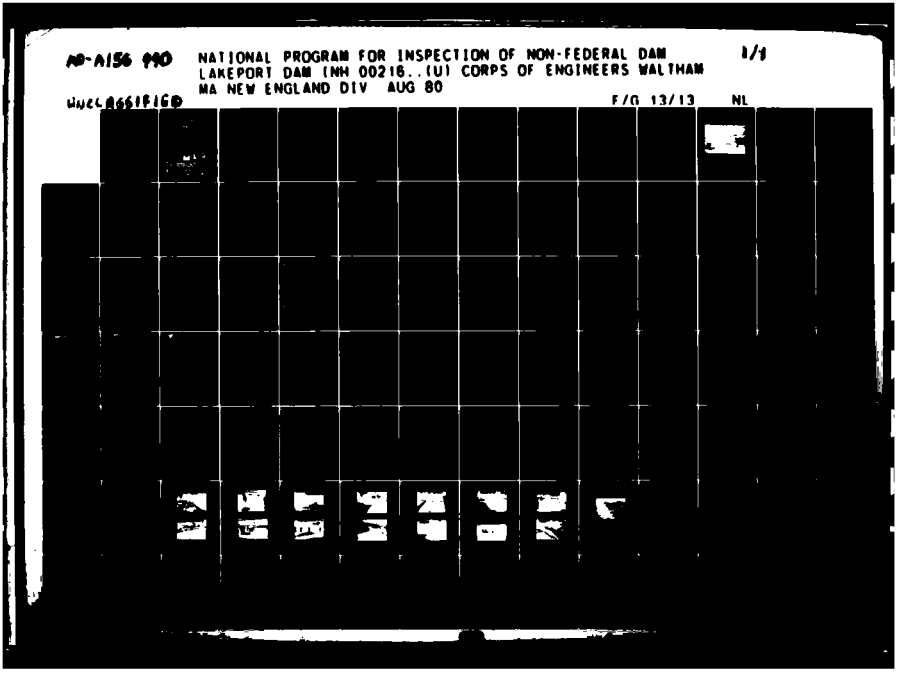

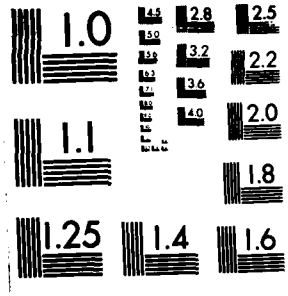

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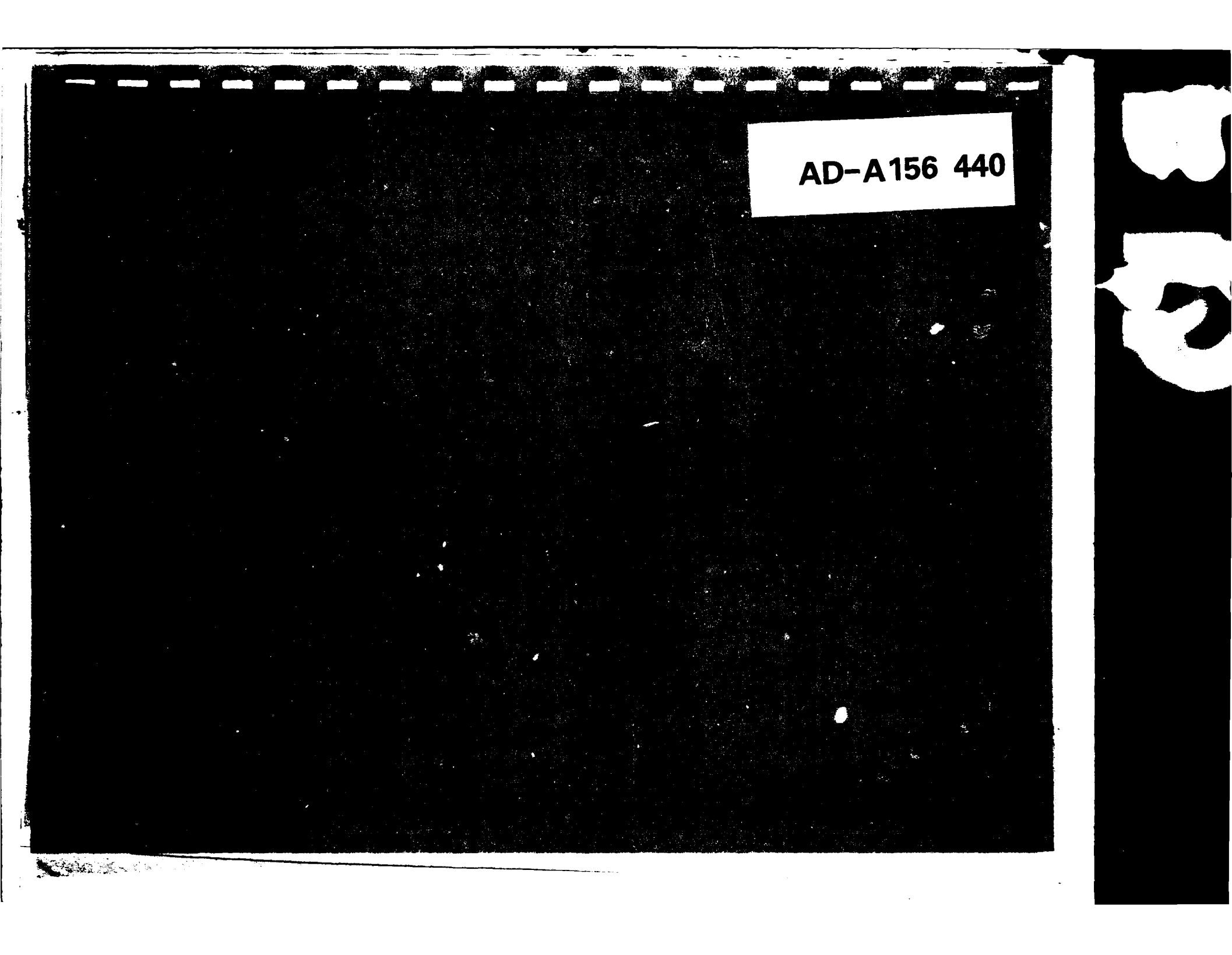

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
Laconia New Hampshire
Winnipesaukee River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a concrete gravity dam with a hydraulic height of 9 ft. and totaling 222 ft. in length. The dam is in good condition. however, there are minor concerns which the NHWRB has indicated that plans for these repairs are underway. It is large in size with a high hazard potential.

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LAKEPORT DAM

NH00216

MERRIMACK RIVER BASIN

LACONIA, NEW HAMPSHIRE

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH00216
Name of Dam:	Lakeport Dam
City:	Laconia
County and State:	Belknap County, New Hampshire
River:	Winnipesaukee River
Date of Inspection:	July 9, 1980

BRIEF ASSESSMENT

Lakeport Dam is a concrete gravity dam with a hydraulic height of 9 feet and totaling 222 feet in length. The dam consists of a 15-foot stoplog spillway structure at the southeast end, an overflow spillway totaling 72 feet in length, a gated section 78 feet in length which consists of three 10'H x 18'W gates, and a 57-foot long concrete retaining wall at the northwest abutment. The dam impounds a reservoir of large size with a maximum usable storage capacity of 165,800 acre-feet. Lake Winnipesaukee has a surface area of about 73 square miles and forms the largest recreational lake in the State of New Hampshire. The drainage area to the dam consists of 363 square miles of hydrologically diverse elements.

The dam is in good condition. Minor concerns are an eroded area on the downstream southeast abutment training wall, surface spalling on the walls of the intake channel to the stoplog spillway, and a minor sinkhole behind the dry-stone-masonry training wall on the northwest side of the discharge channel about 35 feet downstream of the dam. The NHWRB has indicated that plans for these repairs are underway.

Lakeport Dam is large size and high hazard classification based on storage volume and potential for loss of 4 or more lives and excessive property damage in event of a breach. In accordance with the Recommended Guidelines for Safety Inspection of Dams, the test flood is required to be the Probable Maximum Flood (PMF). The PMF inflow was determined to be 218,000 cfs with a runoff of 13.6 inches. Routing of this inflow was determined to raise the level of Lake Winnipesaukee to 509' NGVD. Backwater analysis indicates a drop of 3.8 feet from the lake surface to Lakeport Dam at this elevation. The elevation at Lakeport Dam was determined to be 505.2' NGVD with a discharge of 5,100 cfs. All gates were assumed to be fully opened during a flooding event of this magnitude. The test flood analysis indicates the dam would be overtopped during the PMF by slightly less than one foot. The northwest abutment would not be overtopped. The total discharge capacity of the structure at top of dam is 4,117 cfs which is 81 percent of the routed test flood outflow.

The owner, the New Hampshire Water Resources Board, should implement the recommendations and remedial measures given in Sections 7.2 and 7.3 within two years after receipt of this Phase I inspection report.

Warren A. Guinan

Warren A. Guinan, P.E.
Project Manager
N.H. P.E. 2339

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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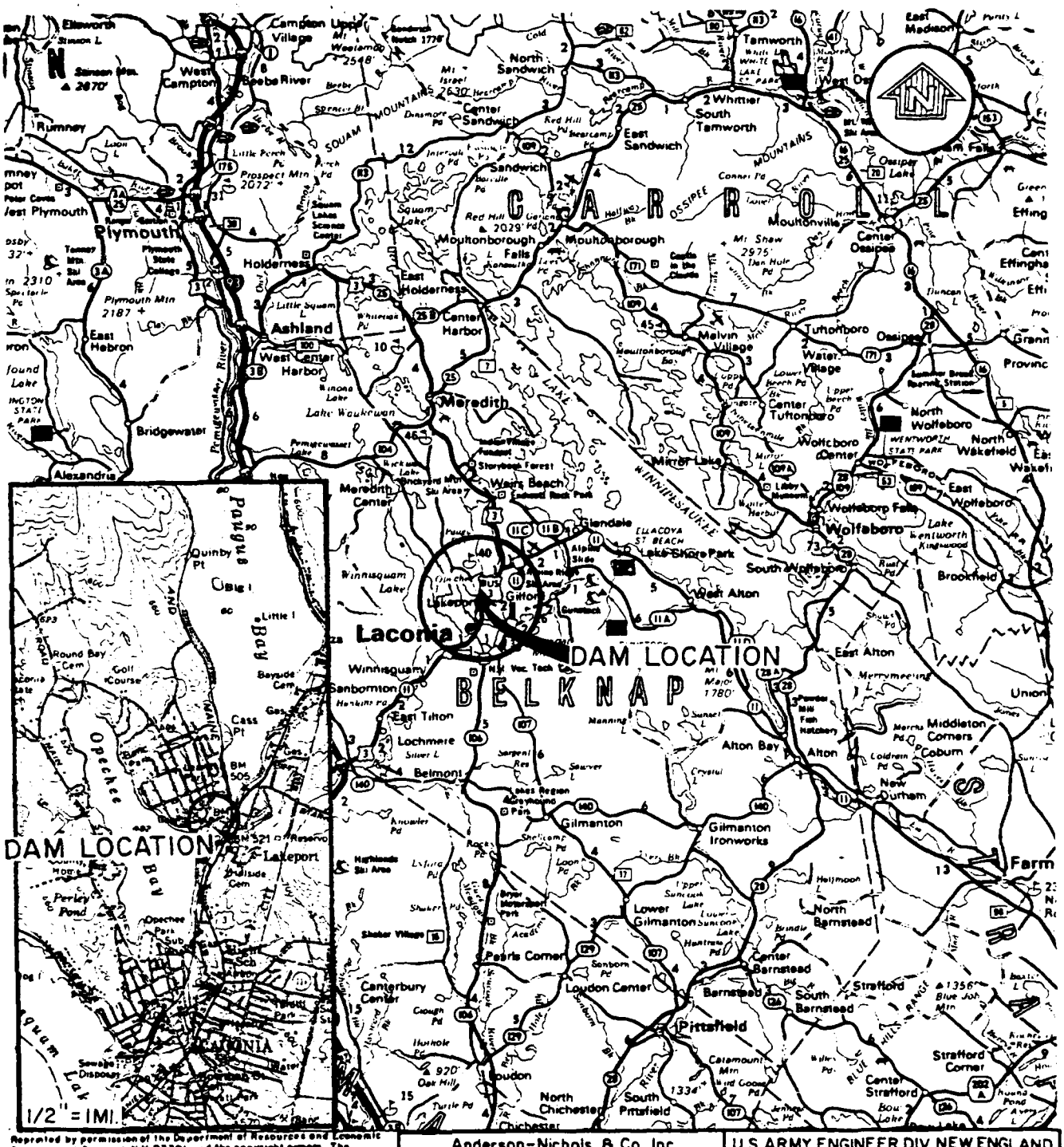
Photo 1 - Overview of Lakeport Dam. July 10, 1980



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SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW HAMPSHIRE OFFICIAL HIGHWAY MAP.

Anderson-Nichols & Co, Inc. CONCORD NEW HAMPSHIRE	U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKEPORT DAM
LOCATION MAP

WINNIPESAUKEE RIVER NEW HAMPSHIRE

			SCALE: SEE BAR SCALE
			DATE: AUGUST 1980

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
LAKEPORT DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of March 22, 1979 from John P. Chandler, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0050, as changed, has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Lakeport Dam is located in the Village of Lakeport within the city limits of Laconia, New Hampshire. The dam is located between Paugus and Opechee Bays, about 4.4 miles downstream of the origination of the Winnipesaukee River at the outlet of Lake Winnipesaukee at the Weirs. Lakeport Dam, although located downstream of the outlet, controls the water level and outflow of Lake Winnipesaukee. Lakeport Dam is located on the Winnipesaukee River approximately 7.6 miles upstream of the rivers' confluence with the Pemigewasset River. The Merrimack River originates at the confluence of the Winnipesaukee and Pemigewasset Rivers in Franklin, New Hampshire. Lakeport Dam is shown on USGS 15-minute Quadrangle, Winnipesaukee, New Hampshire with coordinates approximately at N 43° 32' 54", W 71° 27' 57". The City of Laconia is located in Belknap County, New Hampshire. (See Location Map, page vi .)

b. Description of Dam and Appurtenances. Lakeport Dam is a concrete gravity dam totaling 222 feet in length with a hydraulic height of 9 feet and a structural height of 10 feet. The dam consists of four sections which from the southeast to the northwest abutment, are:

(1) A stoplog gated structure about 15 feet in length with two bays of stoplogs each about 5 feet in length separated by a steel support pier. This stoplog structure is located on the site of an old canal.

(2) The concrete uncontrolled overflow spillway structure, which adjoins the end of the gated section, totals 72 feet in length. The spillway and piers are of the original stone construction, now capped over with concrete. The spillway itself consists of three 15-foot ± wide bays separated by two 10-foot center piers. The crest is 2 feet in width with a total effective weir length of 62 feet. The downstream face slopes at approximately 1'H:0.7'V then continues to a concrete slab about 10 feet in length and 6 inches thick.

The flow through the stoplog spillway and over the overflow spillway discharges into a side channel 13 feet wide and about 50 feet long that runs parallel to the axis of the dam. The floor of this channel is wooden plank. Some discharge is maintained over the stoplogs to keep this planking wet to prevent deterioration. The wall opposite the spillways is stone masonry. This side channel discharges into the main channel.

(3) The gated section, totaling 78 feet in length, consists of three bays, each 18 feet wide, separated by six-foot wide circular nose concrete piers. The floor of each bay is a concrete slab 2 feet thick. The gate sill is a six-inch steel beam with the top flange set flush with the surface of the concrete floor. The three gates are 18'W x 10'H steel skin plated gates which are electrically operated. The gate hoisting mechanism for each gate is operated by an electric motor mounted on the top of a 14½-foot high steel frame super-structure. The motor is operated by a push button located on the southwesterly super-structure column nearest each gate. Electric power is supplied by the Public Service Company of New Hampshire through a main switch in the auxiliary power building which, in turn, is connected to a control panel located on the northwest end of the gated section. Power is also supplied through the control panel to three gate heaters on each gate. Two of the heaters are installed on the gate seals and the third is a sill heater. In case of failure of the normal power supply, a 25 kw Onan generator in the auxiliary power building is available to furnish electric power.

(4) The northwest abutment is formed by a retaining wall extending 57 feet from the end of the gated structure. The wall is the original stone block retaining wall which was later faced on the upstream side with an 18-inch thick reinforced concrete wall. The area is filled with earth and planted in grass.

The main downstream channel averages about 75 feet in width. The westerly stone masonry channel wall extends downstream approximately 190 feet. The east stone masonry channel forms a junction with the side channel wall and extends downstream for approximately 140 feet. The floor of the channel is covered with wood planking for a distance of about 70 feet downstream of the gated section of the dam. Discharge flows into Opechee Bay about 300 feet downstream of the dam.

c. Size Classification. Large (hydraulic height - 9 feet; storage - 165,800 acre-feet) based on storage ($\geq$ 50,000 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. The downstream hazard that would result from a failure of Lakeport Dam was estimated using the procedure set forth in "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs", Corps of Engineers, New England Division, April 1978.

A major breach of the dam was analyzed with pool elevation at 504.32' NGVD and with the dam discharging the normal recreational flow of about 250 cfs. The breach was assumed to occur at either the gated or spillway section of the dam. Both assumed breach conditions would result in a breach discharge in the range of 3,600-3,730 cfs. The flow value is comparable to the 100-year flow of 3,500 cfs used in Reference 2 (see 5.1 b.). Therefore, the profile developed with this discharge provides a reasonable estimate of downstream damage potential should the dam fail at top of dam. A breach discharge of this magnitude could cause an increase in stage of about 3.5 feet on Opechee Bay, or cause the bay to rise to approximately 495.5' NGVD. Correspondence from the NHWRB indicates that flooding would occur on the shores of Opechee Bay with elevation at 494' NGVD. The breach wave itself would be attenuated in Opechee Bay but the flooding discharge would continue downstream into downtown Laconia. According to the files of the NHWRB and confirmed by the references, the maximum safe discharge capacity of the constricted channel in downtown Laconia is 2,600 cfs. Any discharge above this would cause substantial damage. There is a potential for loss of 4 or more lives in this area, especially if a breach occurred without warning. Surcharge storage on Winnisquam Lake would significantly attenuate the flooding conditions. Thus, no significant damages below Winnisquam are anticipated. Lakeport Dam was classified High Hazard based on excessive property damage and potential for loss of 4 or more lives in event of a breach. A detailed downstream hazard map can be seen in Appendix D.

e. Ownership. The earliest recorded ownership was by the Winnipissiogee Lake Cotton and Woolen Manufacturing Company in 1851. Ownership was passed to the Public Service Company of New Hampshire in 1943 and then to the State of New Hampshire Water Resources Board (NHWRB) on March 31, 1958. The current owner is the NHWRB, 37 Pleasant Street, Concord, New Hampshire 03301. Phone: (603) 271-3406.

f. Operator. Mr. Bob Fay, under direction of the NHWRB, is responsible for the operation of Lakeport Dam. Mr. Fay's address is 93 Elm Street, Lakeport, New Hampshire 03246. Phone: (603) 524-1260/9194.

g. Purpose of Dam. Under ownership by the Winnipissiogee Lake Cotton and Woolen Manufacturing Company, the dam was used to create water storage for mills in Lowell and Lawrence, Massachusetts. Records indicate that a building near the damsite used the impoundment for hydro-electric power generation and was removed from service in 1932. The Public Service Company of New Hampshire utilized the dam and its impoundment for storage. After the reconstruction in 1958, no generating capacity was installed. Today, the dam and its impoundment form the largest recreational lake in the State of New Hampshire as well as supply downstream water users.

h. Design and Construction History. No information was found regarding the original design and construction of the dam. The dam was believed to have been constructed or reconstructed by the Winnipissiogee Lake Cotton and Woolen Manufacturing Company in 1851. The dam at this time consisted of a timber structure. Under ownership by the Public Service Company of New Hampshire the dam was rebuilt in 1957-1958. A complete set of design plans is available in the files of the NHWRB. Plans pertinent to this study can be seen in Appendix B. The first plan shown in Appendix B shows the conditions at the dam prior to the 1957-1958 reconstruction. Correspondence from the NHWRB indicates that the Scott & Williams Canal was taken out and the stoplog bay constructed in its place sometime in 1967.

i. Normal Operating Procedures. The NHWRB operates Lakeport Dam in conjunction with Avery Dam on the Winnipesaukee River in downtown Laconia, and Lochmere Dam on Lake Winnisquam. Avery and Lochmere Dams are also owned and operated by the NHWRB. Bob Fay, under direction of the NHWRB, is responsible for the operation of all three dams. The dams are visited at least every other day and gage readings at Lakeport are reported to the NHWRB. Engineers at the NHWRB, in turn, direct any gate operations necessitated by the operator's input. The dam operator lives near and within sight of Lakeport Dam and visits the dam more often if the need is indicated.

Lakeport Dam itself is operated to provide maximum recreational benefits. However, in the contract of sale from the Public Service Company and the NHWRB, it was stipulated that the NHWRB

shall maintain as high a discharge of water from Lakeport Dam as is possible, subject to reasonable use for the recreational interests of the lake. The NHWRB, therefore, provides a minimum discharge of 250 cfs for downstream water users who pay the cost of operation.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 363 square miles (232,320 acres) of various terrain. The normal recreational surface area of Lake Winnipesaukee is 73 square miles which constitutes 20 percent of the watershed. The drainage area is comprised of hydrologically diverse elements. The outlet of Lake Winnipesaukee at the Weirs, about 4.4 miles upstream of Lakeport Dam, contains a drainage area of 351 square miles. Outflow through the constricted channel at the Weirs discharges into Paugus Bay. Lakeport Dam is situated in the constricted channel between Paugus and Opechee Bays.

b. Discharge at Damsite

(1) Outlet works - three (3) 18'W x 10'H, vertical lift gates at invert elevation 495.22' NGVD. Gate discharge capacity (one gate) at top of dam - 1360 cfs @ 504.32' NGVD. Combined capacity (3 gates) - 4080 cfs @ 504.32' NGVD.

(2) The maximum known flood at the damsite occurred on March 31, 1936 when a maximum discharge of 2,890 cfs was recorded.

(3) Ungated spillway capacity at top of dam - 6 cfs @ 504.32' NGVD.

(4) Ungated spillway capacity at test flood elevation - 185 cfs @ 505.2' NGVD.

(5) Gated spillway capacity at top of dam elevation - 30 cfs @ 504.32' NGVD (assuming stoplogs @ 503.4' NGVD)

(6) Gated spillway capacity at test flood elevation - 80 cfs @ 505.2' NGVD (assuming stoplogs @ 503.4' NGVD)

(7) Total spillway capacity at test flood elevation - 265 cfs @ 505.2' NGVD

(8) Total project discharge at top of dam - 4117 cfs @ 504.32' NGVD

(9) Total project discharge at test flood elevation - 5100 cfs @ 505.2' NGVD

c. Elevation (ft. above NGVD based on plans and information found in the files of the NHWRB)

(1) Streambed at toe of dam (gate invert) - 495.22

(2) Bottom of cutoff - unknown

(3) Maximum tailwater - unknown

(4) Normal pool - 504.22±

(5) Full flood control pool - not applicable

(6) Spillway crest - 504.22 (ungated)
- 503.40 (gated)

(7) Design surcharge (original design) - unknown

(8) Top of dam - 504.32

(9) Test flood surcharge - 505.2

d. Reservoir (Length in miles)

(1) Normal pool - 17.5

(2) Flood control pool - not applicable

(3) Spillway crest pool - 17.5

(4) Top of dam - 17.5

(5) Test flood pool - 17.5

e. Storage (acre-feet) Usable storage capacity at USGS gage.

(1) Normal pool - 165,800

(2) Flood control pool - not applicable

(3) Spillway crest pool - 165,800

(4) Top of dam - 165,800

(5) Test flood pool - 208,000

f. Reservoir Surface (square miles)

(1) Normal pool - 73

(2) Flood control pool - not applicable

(3) Spillway crest - 73

(4) Test flood pool - 73

(5) Top of dam - 73

g. Dam

(1) Type - concrete gravity dam with gated section, overflow spillway, and stoplog spillway structure.

(2) Length - 222'

(3) Height - 10' (structural); 9' (hydraulic)

(4) Top Width - varied

(5) Side Slopes - varied

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - available design drawings indicate a sheet pile cutoff wall

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - not applicable

i. Spillway

(1) Type - uncontrolled overflow; stoplog structure

(2) Length of weir - 62'; 10'

(3) Crest elevation - 504.22' NGVD; 503.4' NGVD

(4) Gates - none

(5) U/S Channel - Paugus Bay, which originates at the outlet of Lake Winnipesaukee at the Weirs, is about 4.4 miles in length and ends at Lakeport Dam. The Elm Street Bridge and a USGS gaging station are located immediately upstream of the dam.

(6) D/S Channel - Discharge from the damsite flows approximately 300 feet downstream where it empties into Opechee Bay. The elevation drop through this reach is about 3 feet. The discharge channel at the damsite consists of stone masonry walls which extends downstream 190 feet on the northwest side and 140 feet on the southeast side.

j. Regulating Outlets

(1) Invert - 495.22' NGVD

(2) Size - three (3) 18' W x 10' H

(3) Description - vertical lift gates

(4) Control Mechanism - gate hoisting mechanism for each gate operated by an electric motor

(5) Other - three heaters are installed on each gate. Two of the heaters are installed on the gate seals and the third is a sill heater.

SECTION 2
ENGINEERING DATA

2.1 Design

No design data were found for the original Lakeport Dam. A complete set of design drawings for the 1957-58 reconstruction by the Public Service Company of New Hampshire were found in the files of the New Hampshire Water Resources Board (NHWRB). Those plans pertinent to this study can be seen in Appendix B.

2.2 Construction

No construction records were noted. However, the design drawings were noted "Revised - As built".

2.3 Operation

No operational engineering data were found.

2.4 Evaluation

a. Availability. Information found in the files of the NHWRB included complete 1957-58 reconstruction design plans, operating procedures and historical data on the dam and Lake Winnipesaukee.

b. Adequacy. The information found in the files of the NHWRB and past studies done on the Winnipesaukee River basin, in conjunction with the inspection and hydrologic/hydraulic analyses done for this report, are sufficient to determine the final assessments and recommendations of this investigation.

c. Validity. The majority of the collected data was validated by this study.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Lakeport Dam is a low run-of-river dam which impounds a reservoir of large size. The watershed above the reservoir is moderately to steeply sloping and wooded. The downstream area is moderately sloping.

b. Dam. Lakeport Dam is a concrete gravity dam totaling 222 feet in length with a hydraulic height of 9 feet and a structural height of 10 feet. (See Appendix C - Photos 2 & 3.) The dam consists of four sections which from the southeast to the northwest abutment, are:

(1) A stoplog gated structure about 15 feet in length with two bays of stoplogs each about 5 feet in length separated by a steel support pier. (See Appendix C - Photo 4.) This stoplog structure is located on the site of an old canal.

(2) The concrete uncontrolled overflow spillway structure, which adjoins the end of the gated section, totals 72 feet in length. The spillway itself consists of three 15 ft. ± wide bays separated by two 10-ft. center piers. The crest is 2 feet in width. The downstream face slopes at approximately 1'H:0.7'V then continues to a concrete slab about 10 feet in length and 6 inches thick. (See Appendix C - Photo 5.)

The flow through the stoplog spillway and over the overflow spillway discharges into a side channel 13 feet wide and about 50 feet long and runs parallel to the axis of the dam. (See Appendix C - Photo 6.) The floor of this channel is wooden plank. Some discharge is maintained over the stoplogs to keep this planking wet to prevent deterioration. The wall opposite the spillways is stone masonry. This side channel discharges into the main channel.

(3) The gated section, totaling 78 feet in length, consists of three bays, each 18 feet wide, separated by six-foot wide circular nose concrete piers. (See Appendix C - Photo 7.) The three gates are 18'W x 10'H steel skin plated gates which are electrically operated.

(4) The northwest abutment is formed by a retaining wall extending 57 feet from the end of the gated structure. (See Appendix C - Photo 8.) The wall is the original stone block retaining wall which was later faced on the upstream side with an 18-inch thick reinforced concrete wall. The area is filled with earth and planted in grass.

The southeast abutment consists of soil. No evidence of leakage around the end of the dam was observed. The northwest abutment also consists of soil. Because of grading which was apparently done on this abutment when the concrete gate structure was built it is not possible to identify on the basis of the visual inspection alone where the contact is between the backfill next to the gate structure and the natural abutment soil. A concrete wall retains the upstream side of the abutment soil. Three vertical hairline cracks were observed in this wall. No evidence of leakage around the northwest end of the dam was observed. (In an inspection report dated July 1978 Chas. T. Main, Inc. noted minor leakage discharging downstream of Pier #7 of the gate structure at the northwest abutment, but no seepage was observed at that location at the time of the present inspection.)

c. Appurtenant Structures. The stoplog gated structure, located at the southeast end of the dam, is in fair condition. The top stoplogs appeared to be in good condition; the bottom stoplogs show deterioration and several are leaking. The steel supports were observed to have corroded surfaces. At the top of the stoplog structure at the intake channel the concrete walls are spalled. (See Appendix C - Photos 9 & 10.) Downstream of the stoplog structure on the southeast abutment training wall, the bottom 3 feet of the wall is eroded with reinforcing steel visible. (See Appendix C - Photo 11.) The maximum depth of erosion was observed to be about 6 inches.

A concrete uncontrolled overflow spillway structure is adjacent to the stoplog structure and totals 72 feet in length. The concrete appeared to be in good condition with no visible spalling or staining.

The gated section was found to be in generally good condition with only minor surface erosion on the bottom of the downstream pier walls. The gates themselves consist of three (3) 18'W x 10'H vertical lift gates. Some leakage was observed around the ends of the gates. (See Appendix C - Photo 12.) On the steel components, minor spot rusting was observed. The embedded gate supports were surface rusted. The three gates are electrically operated. Each gate has a 2-hp, 208-volt, 3-phase motor. All three gates were opened and closed without difficulties. In addition, each gate has 2.5-kW, 208-volt, 3-phase side sill heaters and seal heaters. All motors and heaters are in good condition. The existing 200-A, 120/180-volt service in the generator house is in good condition. There is a manual double throw switch to transfer to emergency power. The emergency power consists of a 25-kW LPG Fuel Onan generator that is in good condition. The emergency generator was started and was up to full output in eight seconds. This generator is manually exercised once each month by operating personnel. All conduit, panel boards, wiring, lighting fixtures, etc. appeared to be in good condition.

A wood deck tailrace exists downstream of the gated section and runs for about 70 feet downstream. The wood facing is deteriorated and eroded on the surface and at joints. All planking appeared to be intact.

The wooden walkway (service bridge) was in generally good condition with some deteriorated planks. The dam operator indicated during the inspection that the portion of the wooden walkway between the stoplog structure and the gated structure was soon to be removed. This is being done in an effort to curb vandalism at the dam.

d. Reservoir. Lakeport Dam is the control structure for regulating the level of Lake Winnipesaukee, and is located at the southern end of Paugus Bay. The watershed above Lake Winnipesaukee is moderately to steeply sloping and wooded. The lake is not subject to significant sedimentation. Elm Street Bridge and a USGS gate is located immediately upstream of the dam. (See Appendix C - Photo 13.)

e. Downstream Channel. Dry-stone-masonry training walls are located on both sides of the downstream discharge channel. (See Appendix C - Photos 14 & 15.) One minor sinkhole was noted in the fill behind the training wall on the northwest side of the channel about 35 feet downstream from the dam. (See Appendix C - Photo 16.) This sinkhole appears to be the result of fill behind the wall being washed out by rain-water through the spaces between the rock blocks. A sinkhole behind the training wall on the southeast (left) side of the downstream channel (which was noted in the July 1978 inspection report prepared by Chas. T. Main, Inc.) has apparently been filled in. Minor amounts of relatively fresh placed backfill apparently have been placed behind the downstream training walls at various locations, apparently where fill had washed out through the spaces between the rock blocks. It does not appear that the sinkholes have any adverse effects on the integrity of the dam.

A timber apron covers the bottom of the channel immediately downstream of the dam for about 70 feet. Farther downstream the channel bottom is covered with sand, gravel, and boulders. The downstream channel discharges into Opechee Bay about 300 feet downstream from the dam. A few trees overhang the southeast side of the channel.

3.2 Evaluation

Based on the results of the visual inspection, Lakeport Dam is considered to be in good condition.

A minor sinkhole behind the training wall on the northwest side of the discharge channel could result in localized failure of the training wall if it is allowed to increase in size.

The eroded area on the downstream southeast abutment training wall, if left uncorrected, could effect the integrity of the training wall itself but not effect the integrity of the dam.

The surface spalling on the intake channel of the stoplog spillway does not pose a threat to the integrity of the dam.

SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. The New Hampshire Water Resources Board (NHWRB) operates Lakeport Dam in conjunction with Avery Dam on the Winnipesaukee River in downtown Laconia and Lochmere Dam on Lake Winnisquam, all of which are owned and operated by the NHWRB. Bob Fay, under direction of the NHWRB, is responsible for the operation of all three dams. The dams are visited at least every other day and gage readings at Lakeport are reported to the NHWRB. Engineers at the NHWRB, in turn, direct any gate operations necessitated by the operator's input. The dam operator lives near and within sight of Lakeport Dam and visits the dam more often if the need is indicated.

Lakeport Dam itself is operated to provide maximum recreational benefits as well as provide sufficient discharge for use by downstream water owners who pay for the cost of operation. The maximum regulated flow from the lake is not to exceed 250 cfs between June 1 and October 15 when the level in Lake Winnipesaukee is equal to or less than 502.4'NGVD.

b. Description of Any Warning System in Effect. No formal warning system was found. In case of an emergency, the NHWRB may grant permission to release more than 250 cfs during June 1 to October 15.

4.2 Maintenance Procedures

a. General. Lakeport Dam is visited at least every other day. At that time, conditions at the dam are checked and reported to the NHWRB.

b. Operating Facilities. The dam has three electrically operated gates which are operated periodically. The emergency generator is manually exercised once each month by operating personnel. An operating manual for the generator and gates was at the dam site at the time of the inspection.

4.3 Evaluation

The current operational and maintenance procedures appear satisfactory to ensure that any minor problems encountered can be remedied within a reasonable period of time.

SECTION 5
EVALUATION OF HYDROLOGIC/HYDRAULIC FEATURES

5.1 General

Lakeport Dam controls the water level and outflow of Lake Winnipesaukee, the largest recreational lake in the State of New Hampshire. The drainage area consists of 363 square miles of hydrologically diverse elements. The lake surface area consists of 73 square miles and the peripheral contiguous area constitutes the additional 290 square miles. Lakeport Dam is a concrete gravity dam with a hydraulic height of 9 feet. The dam is actually located 4.4 miles downstream of the outlet of Lake Winnipesaukee at the Weirs. After discharging through the constricted channel at the Weirs, flow enters Paugus Bay. Lakeport Dam is located at a constricted channel downstream of Paugus Bay.

5.2 Design Data

The available data pertinent to the Lakeport Dam comes from four primary sources:

(1) The New Hampshire Water Resources Board (NHWRB) files on the dam;

(2) the backup files for the City of Laconia Flood Insurance Study, prepared for the Federal Insurance Administration by Anderson-Nichols & Company, Inc. (ANCo) of Concord, New Hampshire;

(3) "Lakeport Dam Inspection and Analysis Report", prepared for the NHWRB by Chas. T. Main, Boston, Massachusetts, July 1978; and

(4) Hydraulic Engineering Analysis for Evaluating Flood Stage Reduction on the Winnipesaukee River, New Hampshire, prepared by ANCo for the Corps of Engineers, New England Division, December 1978.

5.3 Experience Data

The maximum known flood at the damsite occurred on March 31, 1936 when a maximum discharge of 2,890 cfs was recorded. The maximum lake level recorded was 505.88' NGVD in May 1954. This was before the 1957-1958 reconstruction. Correspondence from the NHWRB indicates that Lakeport Dam was overtopped July 6, 1973 when the discharge was recorded to be 2,430 cfs. The three gates were each opened 42" and the overtopping elevation was 505.33' NGVD.

5.4 Test Flood Analysis

Lakeport Dam was classified as being large in size having a hydraulic height of 9 feet and a maximum storage capacity of 165,800 acre-feet. The dam was determined to have a high hazard classification. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood was required to be the Probable Maximum Flood (PMF).

The test flood inflow cannot simply be determined by use of the PMF guide curves due to the complexity of the hydrologic and hydraulic conditions which comprise the Winnipesaukee River drainage basin. A detailed PMF analysis was performed in Reference 3 (see 5.1 b.) taking into account the individual hydrologic response characteristics of hydrologically diverse elements which comprise the watershed. This study was reviewed and determined to be a more detailed study than that warranted under the scope of a Phase I report. Therefore, the PMF analysis was utilized for this report and can be seen in Appendix D.

To determine the PMF inflow, the drainage area was separated into the lake area (73 square miles) and the peripheral contiguous area (290 square miles). A unit hydrograph was produced which had a peak PMF inflow of 218,000 cfs and a total runoff volume of 13.6 inches. Routing of this inflow was determined to raise the level of Lake Winnipesaukee to elevation 509' NGVD. Backwater analysis indicates a drop of 3.8 feet from the lake surface to Lakeport Dam at this elevation. Therefore, the elevation at Lakeport was determined to be 505.2' NGVD with a discharge of 5,100 cfs. The rating curve for Lakeport Dam was calculated assuming all gates fully opened. It is the opinion of the NHWRB that the maximum allowable overtopping of the dam at the northwest abutment is one foot. Beyond this the integrity of the structure is questionable. Therefore, during a storm of this magnitude, all gates would be fully opened in order to protect the structure from overtopping failure.

The test flood analysis indicates that the dam would be overtopped during the PMF by 0.88 feet. The northwest abutment would not be overtopped. The total discharge capacity of the structure is 4,117 cfs which is 81 percent of the routed test flood outflow.

5.5 Dam Failure

The downstream hazard that would result from a failure of Lakeport Dam was estimated using the procedure set forth in "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs", Corps of Engineers, New England Division, April 1978.

A major breach of the dam was analyzed with pool elevation at 504.32' NGVD and with the dam discharging the normal recreational flow of about 250 cfs. The breach was assumed to occur at either the gated or spillway section of the dam. Both assumed breach conditions would result in a breach discharge in the range of 3,600-3,730 cfs. The flow value is comparable to the 100-year flow of 3,500 cfs used in Reference 2 (see 5.1 b.). Therefore, the profile developed with this discharge provides a reasonable estimate of downstream damage potential should the dam fail at top of dam. A breach discharge of this magnitude could cause an increase in stage of about 3.5 feet on Opechee Bay or cause the bay to rise to approximately 495.5' NGVD. Correspondence from the NHWRB indicates that flooding would occur on the shores of Opechee Bay with elevation at 494' NGVD. The breach wave itself would be attenuated in Opechee Bay but the flooding discharge would continue downstream into downtown Laconia. According to the files of the NHWRB and confirmed by the references, the maximum safe discharge capacity of the constricted channel in downtown Laconia is 2,600 cfs. Any discharge above this would cause substantial damage. There is a potential for loss of 4 or more lives in this area, especially of a breach occurred without warning. Surcharge storage on Winnisquam Lake would significantly attenuate the flooding conditions. Thus, no significant damages below Winnisquam are anticipated. Lakeport Dam was classified High Hazard based on excessive property damage and potential for loss of 4 or more lives in event of a breach. A detailed downstream hazard map can be seen in Appendix D.

SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual examination indicates the following potential structural problems:

(1) A minor sinkhole behind the training wall on the northwest side of the downstream channel which could lead to localized failure of the training wall if it is allowed to increase in size.

(2) An eroded area on the downstream southeast abutment training wall, if left uncorrected, could effect the integrity of the training wall.

(3) The surface spalling of the concrete walls of the intake channel to the stoplog spillway does not pose a threat to the stability of the dam.

6.2 Design and Construction Data

Available design drawings indicate that the dam rests on a sand foundation and that a steel sheet pile wall has been driven under the upstream side of the dam. The design drawings also show a three-layer graded drainage filter under the concrete gate structure. It is not possible to verify the existence of the sheet pile cutoff wall or the filter on the basis of the visual inspection alone.

6.3 Post Construction Changes

The dam was reconstructed in 1957-58. Files from the New Hampshire Water Resources Board (NHWRB) indicate that the Scott & Williams Canal was taken out and the stoplog bay constructed in its place sometime in 1967.

6.4 Seismic Stability

This dam is located in Seismic Zone 2 and, in accordance with the Phase I Guidelines, does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that Lakeport Dam is in good condition. Minor concerns are:

(1) Minor sinkhole behind the dry-stone-masonry training wall on the northwest side of the discharge channel.

(2) The eroded area on the downstream southeast abutment training wall.

(3) The surface spalling on the walls of the intake channel to the stoplog spillway.

b. Adequacy of Information. Available design data, combined with the results of the visual inspection, are adequate for the purposes of this Phase I inspection.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within two years after receipt of this Phase I report.

7.2 Recommendations

The owner should retain a professional engineer qualified in the design and construction of dams to:

(1) Repair the eroded area on the downstream southeast abutment training wall and the surface spalling on the walls of the intake channel to the stoplog spillway. Oral communication with the NHWRB has indicated that plans for these repairs are underway.

(2) Investigate the effects of the deteriorated tailrace on the integrity of the structure.

The owner should carry out the recommendations made by the engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Fill the sinkhole behind the dry-stone-masonry training wall on the northwest side of the downstream channel and any other sinkholes that may form in the future behind the training walls next to the downstream channel.

(2) Replace deteriorated stoplogs and walkway planking.

(3) All steel should be cleaned and painted.

(4) Visually inspect the dam and appurtenant structures once a month.

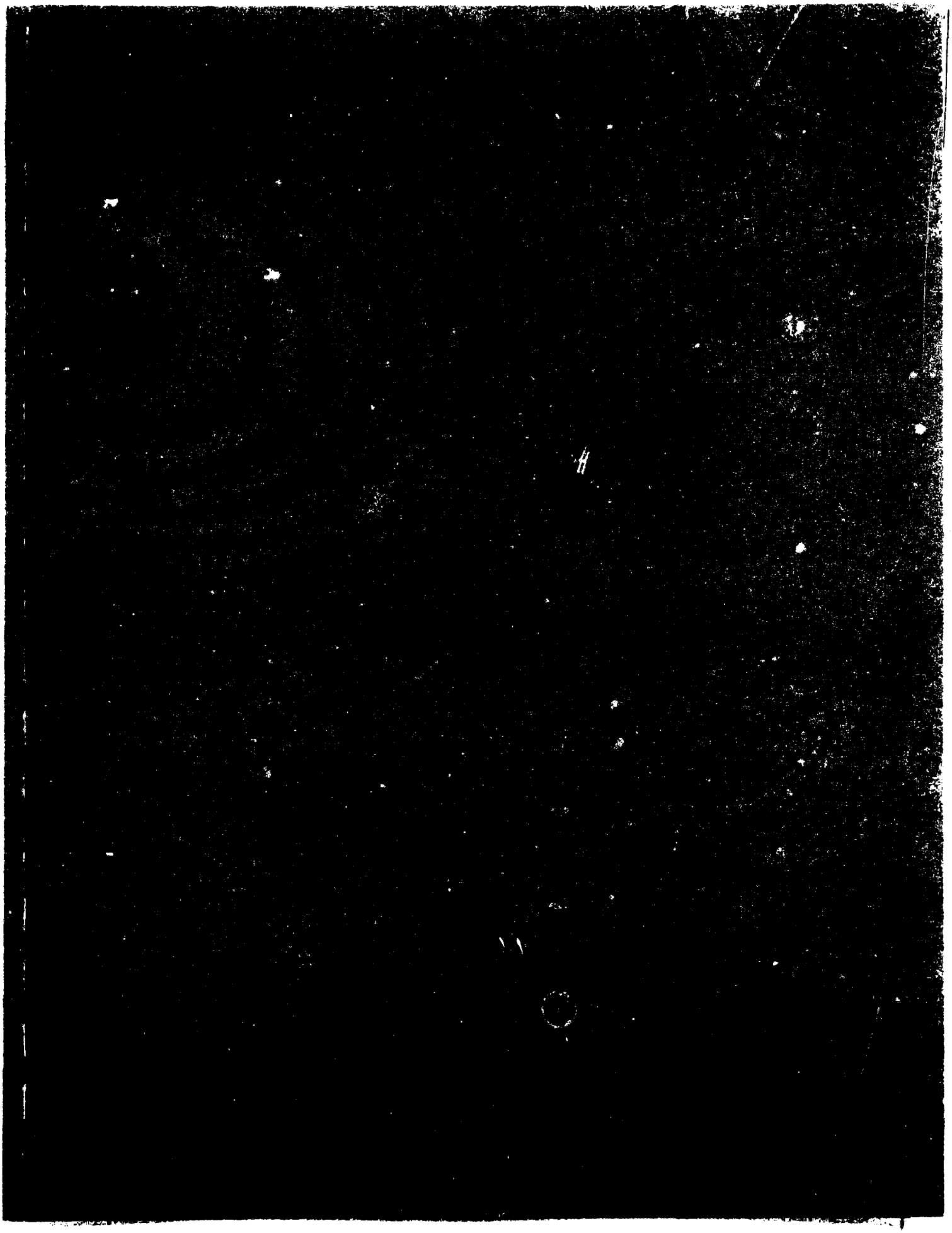
(5) Establish written operating and maintenance procedures.

(6) Engage a registered professional engineer qualified in the design and construction of dams to make a comprehensive technical inspection of the dam once every two years.

(7) Establish a surveillance program for use during and immediately after heavy rainfall, and also a downstream warning program to follow in case of emergency.

7.5 Alternatives

There are no practical alternatives to the recommendations and remedial measures given in Sections 7.2 and 7.3.



VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Lakeport Dam, NH

DATE July 9, 1980

TIME 9:00 AM

WEATHER Warm, sunny

W.S. ELEV. U.S. 504.0 DN.S. 496.2

PARTY:

1. Warren Guinan (ANCo)
2. Stephen Gilman (ANCo)
3. Leslie Williams (ANCo)
4. Greg Comstock (ANCo)
5. Ronald Hirschfeld (GEI)
6. Gary Kerr (NHWRB)
7. Bob Fay (dam operator)
8. Harold Wilcox (ANCo)
9. John Falcione (ANCo)
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	L. Williams/G. Comstock	
2.	Structural Stability	S. Gilman	
3.	Soils & Geology	R. Hirschfeld	
4.	Electrical	H. Wilcox	
5.	Mechanical	J. Falcione	
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Lakeport Dam, NH DATE July 9, 1980

PROJECT FEATURE Stoplog Structure NAME S. Gilman

DISCIPLINE Structural & Soils NAME R. Hirschfeld

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Stoplog structure at southeast abutment.
a. Approach Channel	
Slope Conditions	Good
Bottom Conditions	Soil
Rock Slides or Falls	None
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	None
b. Intake Structure	
Condition of Concrete	Top of concrete walls are spalled.
Stop Logs and Slots	Top logs - good condition Bottom logs - show deterioration and several are leaking. Steel supports - surface corroded.
Southeast abutment wall d/s of stoplog structure	Bottom 3 feet of wall is badly eroded with reinforcing steel visible. Maximum depth of erosion is 6".

PERIODIC INSPECTION CHECKLIST

PROJECT Lakeport Dam, NH DATE July 9, 1980

PROJECT FEATURE Outlet Works - Control NAME S. Gilman

DISCIPLINE Structural NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	See Attached Appendix Notes
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	Minor surface erosion on bottom of downstream walls
Visible Reinforcing	
Rusting or Staining of Concrete	None visible
Any Seepage or Efflorescence	None visible
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	Some leaking around end of gates
Cracks	None
Rusting or Corrosion of Steel	Minor spot rusting except in embedded gate supports which are surface rusted.
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	None
Emergency Power System	25kw ONAN Generator - good
Wiring and Lighting System	Good

PERIODIC INSPECTION CHECKLIST

PROJECT Lakeport Dam, NH DATE July 9, 1980

PROJECT FEATURE Overflow Spillway NAME S. Gilman

DISCIPLINE Structural & Soils NAME R. Hirschfeld

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	A few small trees overhang channel.
Floor of Approach Channel	Soil
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None visible
Spalling	None visible
Any Visible Reinforcing	Southeast abutment downstream face eroded with exposed steel
Any Seepage or Efflorescence	Some on southeast downstream abutment wall.
Drain Holes	None visible
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	A few small trees overhang channel.
Floor of Channel	Timber-plank apron immediately downstream of dam is deteriorated and eroded. Soil and boulders farther downstream.
Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

PROJECT Lakeport Dam, NH DATE July 9, 1980

PROJECT FEATURE Service Bridge NAME S. Gilman

DISCIPLINE Structural NAME

AREA EVALUATED	CONDITION	
OUTLET WORKS - SERVICE BRIDGE	Steel	Wood
a. Super Structure		
Bearings	Good	Good
Anchor Bolts	Not visible	Surface rusted
Bridge Seat	Not applicable	Not applicable
Longitudinal Members	Good condition - minor surface erosion	Good condition
Underside of Deck	Not applicable	See Deck
Secondary Bracing	Not applicable	None
Deck	Good condition	Many planks are deteriorated
Drainage System	Not applicable	Not applicable
Railings	Good condition	None
Expansion Joints	Not applicable	Not applicable
Paint	Good condition	Not applicable
b. Abutment & Piers		
General Condition of Concrete	Good condition	
Alignment of Abutment		
Approach to Bridge		
Condition of Seat & Backwall	Good condition	Good condition

APPENDIX NOTES
Lakeport Dam

Left (Southeast) Gate Channel

Concrete Abutments	Good condition. Minor surface erosion at bottom of walls - exposing surface aggregate, ½" maximum depth at downstream of stoplog supports (2' up from bottom).
Steel Gate Supports d/s (embedded in concrete)	Bottom 4 feet rusted on surface. Remainder is painted with minor spot rusting.
Gates	Good condition. No evidence of corrosion or deterioration. Steel upstream face is surface rusted below water line.
Catwalk	Steel: Good condition. Paint: Good condition.
Super Structure	Good condition. No indication of corrosion or instability.
Gate Supports	Upstream steel is surface corroded.
Channel Bottom	Good condition. Minor surface erosion.

Middle Gate Channel

Concrete Abutments	Downstream. Good condition. Minor surface erosion at bottom of walls, exposing coarse aggregate. 3/8" maximum depth erosion downstream of stoplog supports (2' up from bottom). Upstream. Good condition. General loss of surface laitance below water line.
Embedded Gate Supports	Good condition. Bottom 4' surface rusted.
Gates	Good condition. Some deterioration of downstream wood facing. Bottom 2 horizontal steel supports are surface rusted. Upstream face is surface rusted below water line.

Middle Channel (continued)	
Catwalk	Good condition. Minor spot surface corrosion.
Super Structure	Good condition. No indication of surface corrosion or instability.
Channel Bottom	Not visible because gate could not be closed completely.
Right Gate Channel (Northwest)	Same as middle and left gate channels.
Wood Deck Tail Race	Wood facing is deteriorated and eroded on surfaces and joints. No major loss of planking - all appear to be intact.

APPENDIX B

ENGINEERING DATA

NEW HAMPSHIRE WATER RESOURCES BOARD
Room 316, State House Annex
Concord, New Hampshire 03301

Dear:

In reply to your inquiry concerning the operation of Lake Winnipesaukee, a summary of the previous operations is presented. Also, the proposed operation of Lake Winnipesaukee is noted with other pertinent information.

Lakeport dam was constructed or reconstructed by the Winnipissiogee Lake Cotton and Woolen Manufacturing Company in 1851 for water power at the dam and conservation water storage for mills in Lowell and Lawrence, Massachusetts. The Company had been incorporated in 1831. This Company had to buy flowage rights at many points around the lake. The original owner of the dam sold the dam, flowage and water rights to Public Service Company of New Hampshire in 1943. In 1958, the State of New Hampshire purchased the Lakeport dam, flowage and water rights from Public Service Company of New Hampshire after it had rebuilt the old dam. Since 1958, Water Resources Board, an agency of the State of New Hampshire, has operated the dam with regard to both the downstream water users, downstream property adjacent to Winnipesaukee as well as shore property on the lake. Downstream water users pay the cost of operation, debt service and retirement over a thirty year period.

From 1943 to 1958, Public Service Company of New Hampshire operated the lake in its interest with due regard to lake and river interests

Water Resources Board offered advice as to discharges during critical periods which they generally followed.

Since 1958, Water Resources Board has transferred the emphasis to favor the shore interests but not at undue expense of the downstream water users and river front property.

In the springs of 1953 and 1954, very high lake levels and discharges were necessary. This Board requested and obtained an engineering study prepared for the Corps of Engineers in 1957. This study was entitled "Engineering Study and Report for Control of Flood Discharges on Winnipesaukee River, New Hampshire " by Fenton G. Keyes Associates. This report estimated construction necessary to increase the flow capacity of Winnipesaukee River at $4,398,000 with annual charges of $155,500. This results in an unfavorable cost-benefit ratio. However, certain improvements have been undertaken to improve conditions such as increasing discharge capacity at the rebuilt Lakeport dam.

The planned operation from 1958 through 1967 lowers the lake about two feet below "full" pond on March 1, allows it to rise to full or three inches over full on June 1. On July 1, the target level is "full" pond with gradual lowering due to discharge during July and August until the level reaches about one foot below "full" on Labor Day. This rate of lowering is continued through September and October with a level about 22 inches below full on November 1. From November 1 to March 1, the level is stabilized between 22 to 24 inches below full, runoff conditions permitting.

Possible revised operations would attempt to maintain the level of the lake between full and six inches below full between July 1 and Labor Day and twelve inches drop between July 1 and November 1. During November and December, the lake would be lowered twelve inches to near the present first of year level. The winter and spring operation would not be changed.

There are minimum flow restrictions of 250 cubic feet be second in the deed the State has, as well as by law under certain conditions. Present channel conditions below Lakeport dam restrict the discharge to not over 2600 cubic feet per second which is possible only when downstream inflow has returned to normal.

For over twenty years, snow water surveys have been conducted on the drainage area for use in gauging the discharge to maintain proper lake levels.

From the chart of lake levels, in 1953, the level of the lake reached 505.80' above Mean Sea Level although the discharge was 2,110 cubic feet per second. In 1954, the lake reached 505.86' with 2450 cubic feet per second discharge. Tabulated damages on the lake for these two high levels were estimated to be more than $250,000.

Also, from the chart, the 1941 level of the lake dropped to 500.63 feet above Mean Sea Level in December with the discharge limited to 20 cubic feet per second. From this years, 1941, 1953 and 1954, it shows that the inflow into Lake Winnipesaukee varies greatly with resulting wide variations in summer levels. Evaporation alone takes about twenty inches off of Lake Winnipesaukee between June 1 and October 1 of most years. This averages over 300 cubic feet per second evaporated. In dry years, the discharge for the period is only 250 cubic feet per second.

There has been a law regulating maximum discharge from June 1 through September 15 to 250 cubic feet per second when the lake is below 502.4' above Mean Sea Level from 1911 through 1949 when the restriction was extended through October 15. This Board has seen that this law has not been violated.

Hurricane storms and heavy fall rains can raise the lake as much as seven and one-half in 4 days. ~~This is the main reason at least six inches below "full" lake is aimed by Labor Day.~~ However, discharges may be increased if at or near full lake to reduce the full impact of these storms.

It is hoped that you will understand the complexity of operating Lake Winnipesaukee for the benefit of all concerned. The number one "bugaboo" is the variations in weather and precipitation. To have cut off all discharge from Lake Winnipesaukee in 1965 between May 1 and September 1 would have raised the July 4 level from 502.84' to 503.55' and September 1 level from 501.82' to 503.13', which could not be done due to dead regulation and Federal Power Commission regulations.

Encl. Chart

George M. McBa, Jr.
Chairman

7205

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON RESERVOIRS & PONDS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 130.01

Town Laconia : County Belknap

Stream Winnipesaukee R.-Outlet Lake Paugus

Basin—Primary Merrimack R. : Secondary Winnipesaukee R.

Local Name Lakeport Dam

DRAINAGE AREA ✓

Controlled 363 Sq. Mi.: Uncontrolled 0 Sq. Mi.: Total ~~367.10~~ 363 ✓ Sq. Mi.

ELEVATION vs. WATER SURFACE AREA vs. VOLUME

Point	Elevation ~~Head~~ Feet	Surface Area Acres	Volume Acre Ft.
(1) Max. Flood Height			
(2) Top of Flashboards	504.76	44,586	
(3) Permanent Crest	502.32		
(4) Normal Drawdown	~~507~~ 500.59		7,190,000,000. ✓
(5) Max. Drawdown	494.55		18,240,000 ac ft ✓
(6) Original Pond			

Base Used U.S.G.S. : Coef. to change to U.S.G.S. Base

RESERVOIR CAPACITY

	Total Volume	Useable Volume
Drawdown	ft.	ft.
Volume	18,240,000,000 ~~cu. ft.~~ ✓	ac. ft.
Acre ft. per sq. mi.		
Inches per sq. mi.		

USE OF WATER Recreation Storage for Industrial and Public Utility R&*

OWNER ~~P.S.Co., of N.H. and Int.Paper & Power Co.~~ Winnipesaukee Lake, Lakeport & Weirs Mfg Co.

REMARKS

P.D. 4

Tabulation By ~~BLT~~ Date 10-30-41 ~~10/31/39~~

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 130.01

Town Laconia : County Belknap

Stream Winnipesaukee R.-Outlet ~~Lake Winnipesaukee~~ Lake Winnipesaukee (Paugus Bay)

Basin-Primary Merrimack R. : Secondary Winnipesaukee R.

Local Name Lakeport Dam

Coordinates—Lat. ~~43°30' 13,400ft.~~ : Long. ~~71°30' 3,900ft.~~

GENERAL DATA

Drainage area: Controlled 363 Sq. Mi.: Uncontrolled 0 Sq. Mi.: Total ~~367.10~~ 363 Sq. Mi.

Overall length of dam 300 ft.: Date of Construction prior to 1886 (1851)

Height: Stream bed to highest elev. 14 ft.: Max. Structure 11 ft.

Cost—Dam : Reservoir

DESCRIPTION Gravity-Split stone, concrete on earth

Waste Gates

Type

Number 4 : Size 6 ft. high x 6 ft. wide

Elevation Invert 8.29 : Total Area 144 sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on: Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction

Length—Total (20, 6' bays) ft.: Net 127 ft.

Height of permanent section—Max. 11 ft.: Min. ft.

Flashboards—Type removable stop planks : Height 1.94 ft.

Elevation—Permanent Crest 502.32 : Top of Flashboard 504.26

Flood Capacity cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 3.0 ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER ~~P.S.C.~~ P.S.C. & International Paper & Power Co.

REMARKS

Tabulation By RLT Date 12/29/38

B&B21284

NEW HAMPSHIRE WATER CONTROL COMMISSION 66
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 130.01

Town Laconia : County Belknap

Stream Winnipesaukee River Outlet Lake ~~Busiris~~ Paugus

Basin-Primary Merrimack R. : Secondary Winnipesaukee R.

Local Name Lakeside Dam

Coordinates—Lat. 43° 30' + 17.400 : Long. 71° 30' -2900'

GENERAL DATA 367.10

Drainage area: Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 360 Sq. Mi.

Overall length of dam 300 ft.: Date of Construction .....

Height: Stream bed to highest elev. 14' ft.: Max. Structure 11' ft.

Cost—Dam .....: Reservoir .....

DESCRIPTION Gravity— Split Stone— Concrete on earth

Waste Gates

Type .....

Number 4 : Size 6' ft. high x 6' ft. wide

Elevation Invert 8.29 : Total Area ..... sq. ft.

Hoist .....

Waste Gates Conduit

Number .....: Materials .....

Size ..... ft.: Length ..... ft.: Area ..... sq. ft.

Embankment

Type .....

Height—Max. ..... ft.: Min. ..... ft.

Top—Width .....: Elev. ..... ft.

Slopes—Upstream ..... on .....: Downstream ..... on .....

Length—Right of Spillway .....: Left of Spillway .....

Spillway

Materials of Construction .....

Length—Total (20-6' bays) 127 ft.: Net ~~1271~~ 120 ft.

Height of permanent section—Max. ..... ft.: Min. ..... ft.

Flashboards—Type Removable Stop Planks : Height 24" 1.94 ft.

Elevation—Permanent Crest 502.32 : Top of Flashboard .....

Flood Capacity ~~1925~~ cfs.: ~~5.2~~ cfs/sq. mi.

Abutments

Materials: .....

Freeboard: Max. 3.0' ft.: Min. ..... ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Winnipesaukee Lake Cotton & Woolen Mfg Co.
Room 3511, 200 East 42nd St N Y City

REMARKS

P.S. Co. of N.H. &
Int. Paper & Power Co

Tabulation By A A N & R L T Date December 29, 1938.

B&B21254

7205

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON RESERVOIRS & PONDS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 130.01

Town : Laconia : County Belknap

Stream Winnipesaukee River (Outlet Lake Paugus) PAUGU

Basin—Primary Merrimack R. : Secondary Winnepesaukee R.

Local Name Lakeport Dam

DRAINAGE AREA 367.10

Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 360 Sq. Mi.

ELEVATION vs. WATER SURFACE AREA vs. VOLUME

Point		Head Feet	Surface Area Acres	Volume Acre Ft.
(1)	Max. Flood Height			
(2)	Top of Flashboards			
(3)	Permanent Crest			
(4)	Normal Drawdown	(37)	1206	
(5)	Max. Drawdown	(Lake Winnepesaukee)	586	161,000
(6)	Original Pond		1206	

1206 Winnipesaukee 44,586 D.D. 3.7

Base Used .....: Coef. to change to U.S.G.S. Base .....

RESERVOIR CAPACITY

	Total Volume	Useable Volume
Drawdown	3.7 ft.	ft.
Volume	ac. ft.	ac. ft.
Acre ft. per sq. mi.		
Inches per sq. mi.		

USE OF WATER Conservation

OWNER Winnipeseogee Lake Cotton & Woolen Mfg Co
Room 3511- 200 East 42nd St. N Y City

REMARKS

Tabulation By A A N & R L T Date December 28, 1938

Rec'd

Jacobsen	
Holmgren	✓
Return to	
Filed	
File No.	

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire

October 28, 1938.

Winnepesaukee Lake Cotton & Woollen Mfg Co.,
[illegible] E 42nd St.,
N Y City

RE: Lake Paugus Outlet Dam. W. C. C. No. 160.01

Gentlemen:

In order that we may determine the magnitude and extent of the flood of September 21-24 just passed, we are requesting the various dam owners in the State to supply us with the following information:

1. Was this dam injured? Ans. No

2. If so, to what extent? Ans.

3. Did all flashboards go out? Ans. No

4. What was the maximum height of water over the permanent crest of spillway? Ans. Max. elevation 36.75 on Sept. 25th
Full Lake 44.00

5. At what day and hour did the maximum flood height reach your dam? Ans.

	Daily		Daily
Sept 21	500 cfps	Sept 25	460 cfps.
" 22	510 "	" 26	510 "
" 23	500 "	" 27	510 "
" 24	460 "	" 28	500 "

6. Any other interesting information regarding the flood or rain fall may be given on the back of this sheet, or attach sheets.

Will you please return this letter with as much information as you can give us as promptly as possible. A self-addressed envelope is attached hereto.

We thank you for your cooperation.

Very truly yours,

Richard S. Holmgren

Richard S. Holmgren
Chief Engineer

CDC:GMB
Enc.

State of New Hampshire
PUBLIC SERVICE COMMISSION
CONCORD

COMMISSIONERS
JOHN W. STORRS, CHAIRMAN
FRED H. BROWN
MAYLAND H. MORSE

CLERK-ACCOUNTANT
WILLIAM W. TIRRELL

I-2255

June 4, 1929.

Mr. John W. Storrs, Chairman,
N. H. Public Service Commission,
Concord, New Hampshire.

Dear Sir:

Re: Lakeport dam - Laconia.

On the ninth day of May, 1929, I visited the Lakeport dam at the outlet of Lake Paugus, as to the dam itself, there is no indication but that it is safe. At the easterly end of the dam there are three outlets or bays, these served certain industries in the past, the two westerly bays have not been used for some years and are closed by timber bulkheads, the easterly one served the Scott & Williams factory, the water flowing through this bay then through an open canal to the mill. A break in the canal wall some distance below the dam necessitated closing the bay by temporary sheet piling and resulted in the loss of water power to the mill.

I was informed that arrangements had been made with Scott & Williams whereby a reinforced concrete intake

(that could be closed by stop plank) was to be built in the easterly bay and that the canal would be restored, I was further informed that they intended to permanently close the two westerly bays by reinforced concrete bulkheads.

May 30, 1929, I was informed (on the ground) that it had been definitely settled to do as above stated and that work would be begun June 3, 1929. June 3, 1929, I was informed (by telephone) that work had begun.

Respectfully submitted,

N. H. PUBLIC SERVICE COMMISSION,

Samuel J. Lord,
Engineer.

SJL:PDW

Form E1A
4843

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5477

TOWN	LACONIA	TOWN NO. 1	STATE NO.
RIVER STREAM	Winnipesaukee River - Outlet Lake Paugus		
DRAINAGE AREA	360 Sq. Mi.	POND AREA	
DAM TYPE	Gravity	FOUNDATION NATURE OF	Earth
MATERIALS OF CONSTRUCTION	Split Stone, Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	Approx. 14'	TOP OF DAM TO SPILLWAY CRESTS	3'
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	127' 20 - 6' bays	4 - 6'x8' Gates	LENGTH OF DAM Approx. 1[illegible]0'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	24" Removable stop planks		
OPERATING HEAD CREST TO N. T. W.	9' ±	TOP OF FLASHBOARDS TO N. T. W.	
WHEELS, NUMBER KINDS & H. P.	2 used - 4 not used 1 - wheel for gate power		
GENERATORS, NUMBER KINDS & K. W.			
H. P. 90 P. C. TIME 100 P. C. EFF.		H. P. 75 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS	See Case Nos. I-2231, I-2255, I-1916, I-2280		

REMARKS: Winnipiseogee Lake Cotton & Woollen Mfg C

OWNER: ~~International Hydro Electric~~ Co.

CONDITION: Good

MENACE: Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made Aug. 21, 1936, according to notification to owner dated Aug. 10, 1936, and bill for same is enclosed.

D. Waldo White
Chief Engineer

Aug. 22, 1936
Copy to Owner

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Merrimack NO. 1 — I-5477
RIVER Winnipesaukee MILES FROM MOUTH D.A.SQ.MI. 360 (370)
TOWN Laconia OWNER International Hydro Elec Co. Boston
LOCAL NAME OF DAM Lake Opechee
BUILT 1854 DESCRIPTION Gravity — Split Stone, Concrete on Earth Granite Blocks on E
POND AREA-ACRES 1,200 DRAINAGE DRAFT FT. 3.0 POND CAPACITY-ACRE FT. 16,000
HEIGHT-TOP TO BED OF STREAM-FT. 14 MAX. MIN.
OVERALL LENGTH OF DAM-FT. 300 MAX. FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV. U.S.G.S. 502.32 LOCAL GAGE 499.46
TAILWATER ELEV. U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 127 FREEBOARD-FT. 3
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST 2'-4" 12" Pine
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

NO.	WIDTH MAX. OPENING	DEPTH SILL BELOW CREST
4	6	6.9

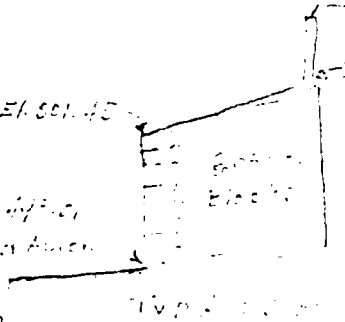
REMARKS Outlet Lake Opechee
Condition Good

POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE
	6		9±			
	7					
		105	10	Scott Williams Inc	USGS list.	
		160	12	H.H. Wood & Co.		

USE Power Conservation

REMARKS Replaced 1 wheel for gate power
4 wheels not used
Data obtained from C.P. Williams, Observer at Lakeport Dam.
Plant capacity can be obtained from N.E. Power Co. Boston



DATE 8/21/36

INTERNATIONAL PAPER COMPANY

PERSHING SQUARE BUILDING

PARK AVE. & 42ND STREET

New York

HYDRO-ELECTRIC DIVISION
CHESTER S. COLSON
HYDRAULIC ENGINEER

June 1, 1927

Subject: DAM AT LAKEPORT

New Hampshire Public Service Commission,
Concord, N.H.

Gentlemen:

As you requested in your letter of May 12th an inspection of the dam of the Lake Winnipiseogee Cotton & Woolen Company at Lakeport, N.H., was made on May 26th by Mr. Nelson of this office and Mr. Lord of your office.

This dam consists of a series of masonry piers about 8 feet by 20 feet in plan spaced from 20 to 23 feet on centers with timber stop logs between the piers and with four inch splined sheeting driven into the gravel on the upstream side to form the water seal. The masonry piers are built of squared stone with courses 16 or 18 inches deep, laid dry. A timber mat covers the whole area under and between the piers and extends several feet down stream from the piers.

The dam holds back a head of water of about 11 or 12 feet when Lake Winnipiseogee is full to the 44 inch mark.

The sheeting planks and some of the stop logs in the section of the dam East of the gates are decayed somewhat. The timber in the section between piers three and four (counting from the East end of the dam) is in the worst condition and we are now asking for tenders covering repairs to this section.

Mr. Charles J. Hayford, Mayor of Laconia and Mr. French, City Engineer of Laconia were present at the inspection and Mr. French said that if one of the timber sections between the piers in the dam gave way he feared that the foundations of the piers in the bridge at Depot Street which is located 50 or 60 feet up stream from the dam might be endangered by the scouring action of the water. As we have already in 1922 drawn as much as 1500 cubic feet per second from the Lake for a period of a week, we do not feel that the failure of one of the timber sections would endanger the bridge pier foundations, if they were properly built, as it is not likely that the discharge between two of the piers would amount to more than 1000 to 1200 cubic feet per second.

For our own best interests however, we wish to keep the dam in a serviceable condition, and we thank you for calling the matter to our attention.

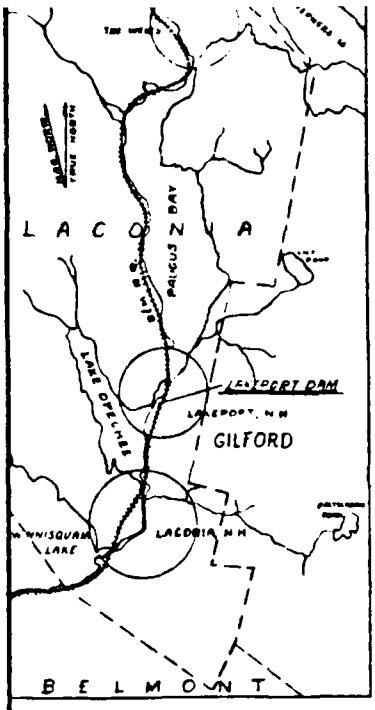
Yours very truly,

INTERNATIONAL PAPER COMPANY

Chester S. Colson
H. Jr. R.

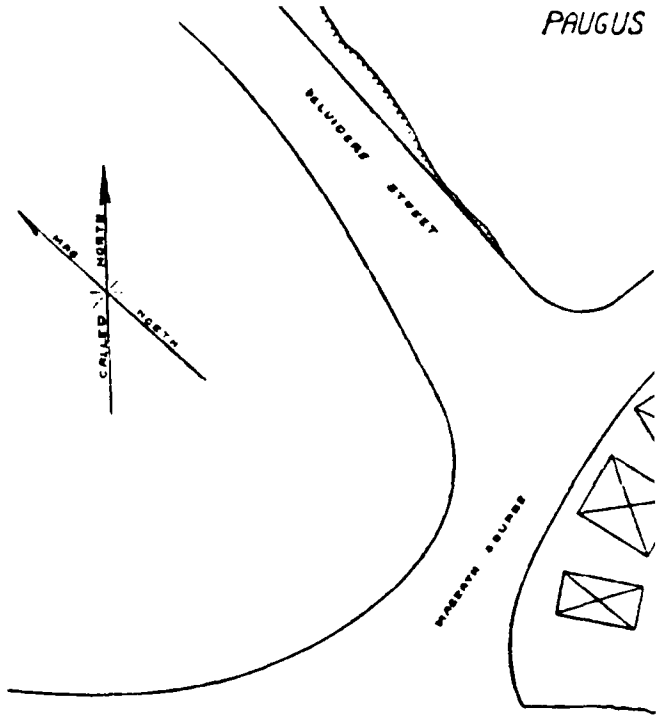
CHESTER S. COLSON
Hydraulic Engineer

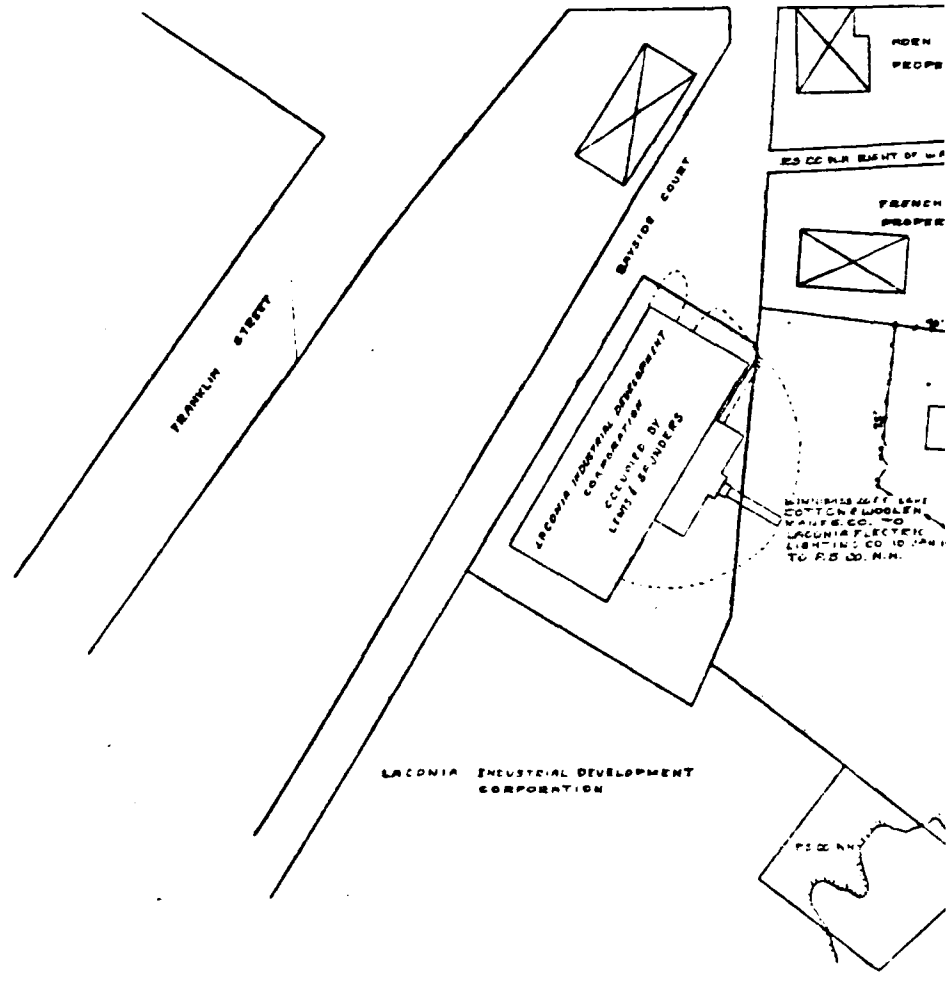
HMN:R

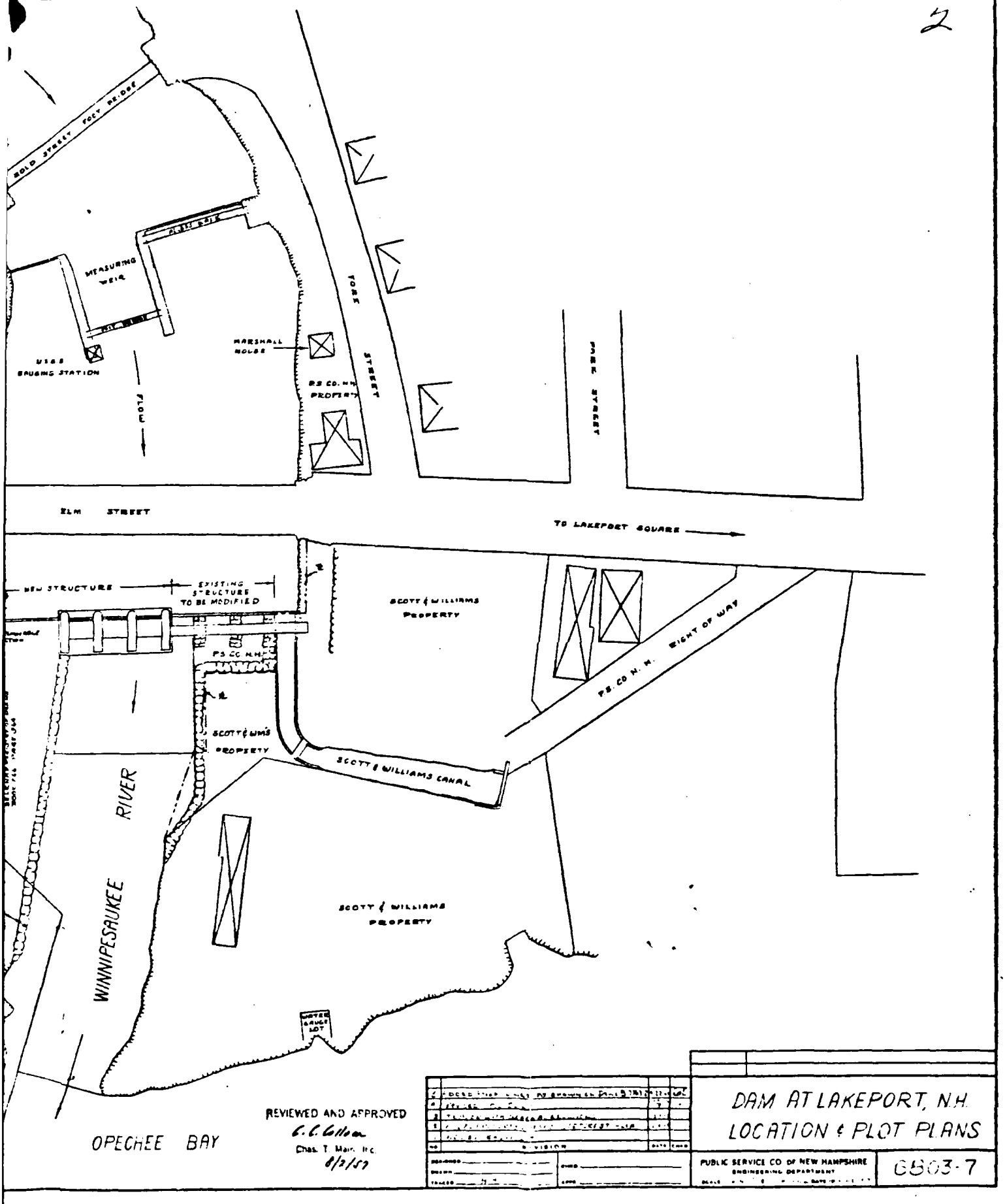


LOCATION PLAN

PAUGUS





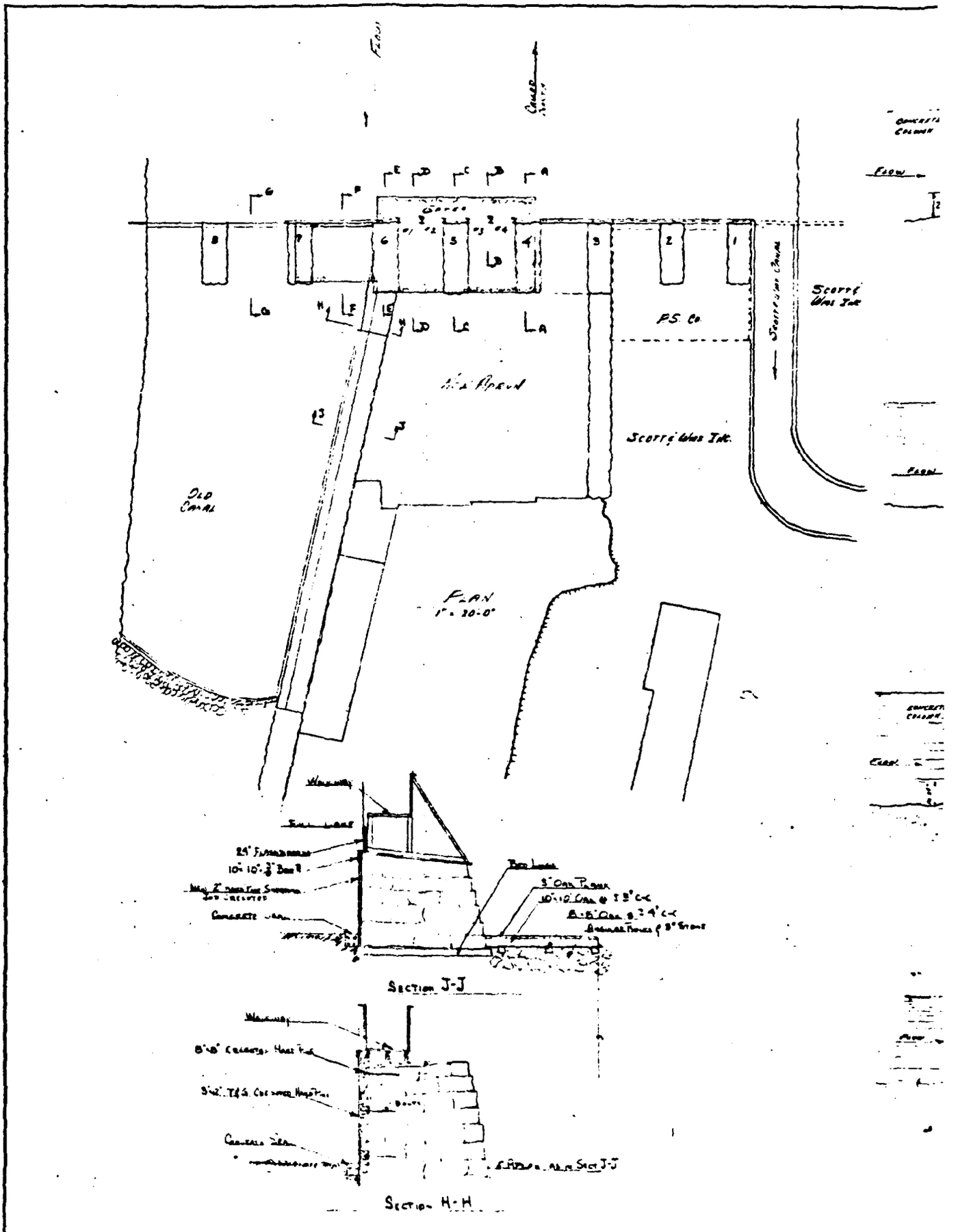


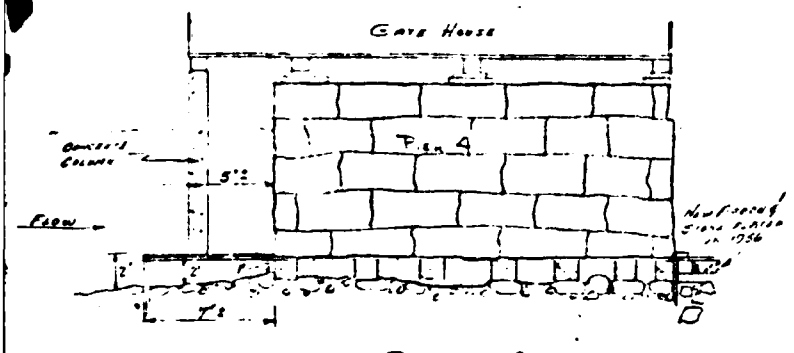
REVIEWED AND APPROVED
C. C. Gilson
Chas. T. Main, Inc.
8/2/57

DAM AT LAKEPORT, N.H.
LOCATION & PLOT PLANS

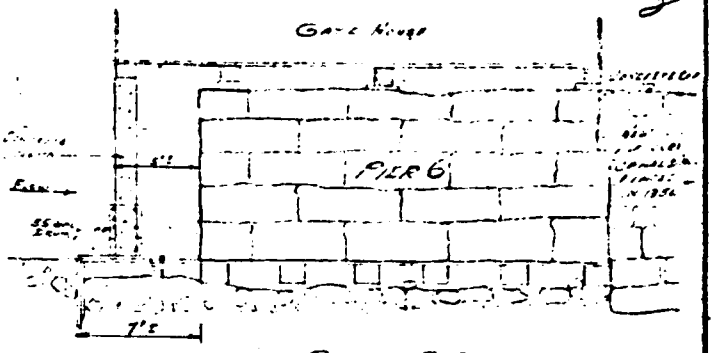
PUBLIC SERVICE CO OF NEW HAMPSHIRE
ENGINEERING DEPARTMENT

6503-7


Scott's Run Inc.
P.S. Co
Scott's Run Inc.
OLD CANAL
PLAN
1" = 20'-0"
SECTION J-J
SECTION H-H



Section A-A



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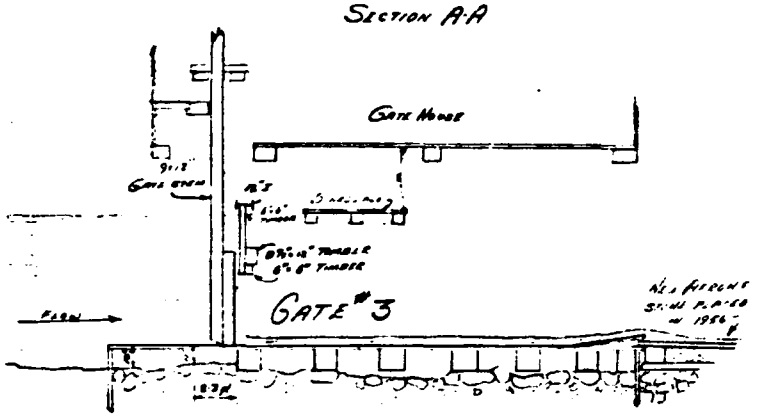
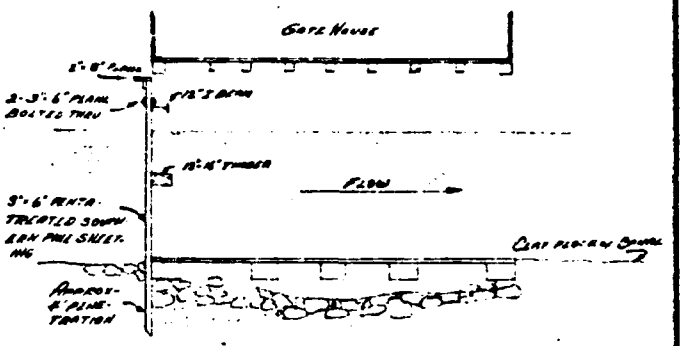


Section B-B



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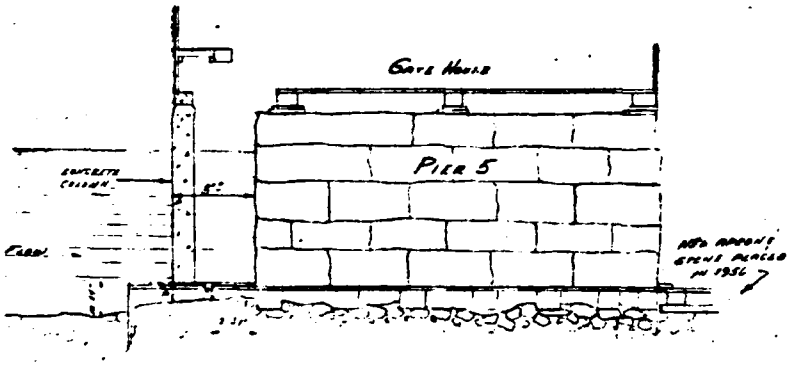

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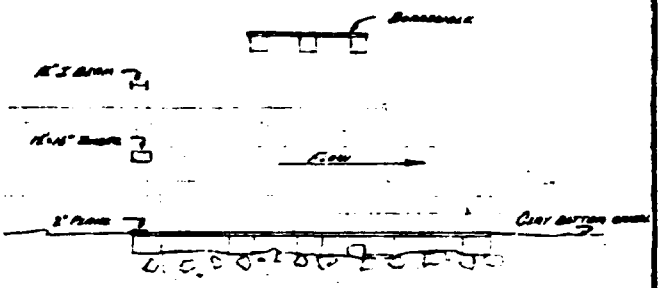
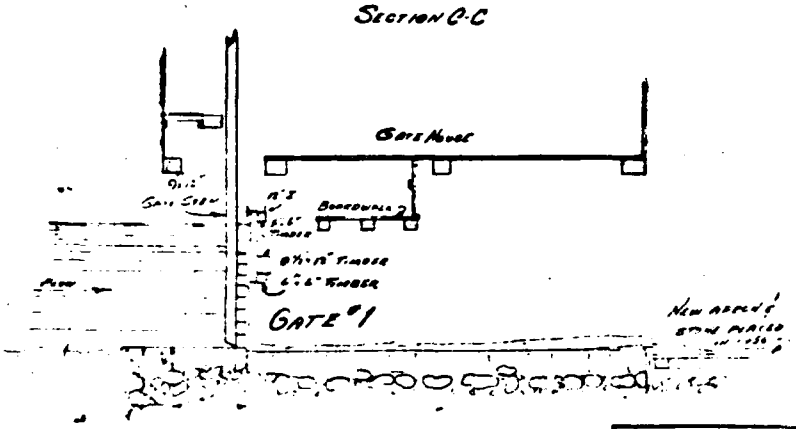
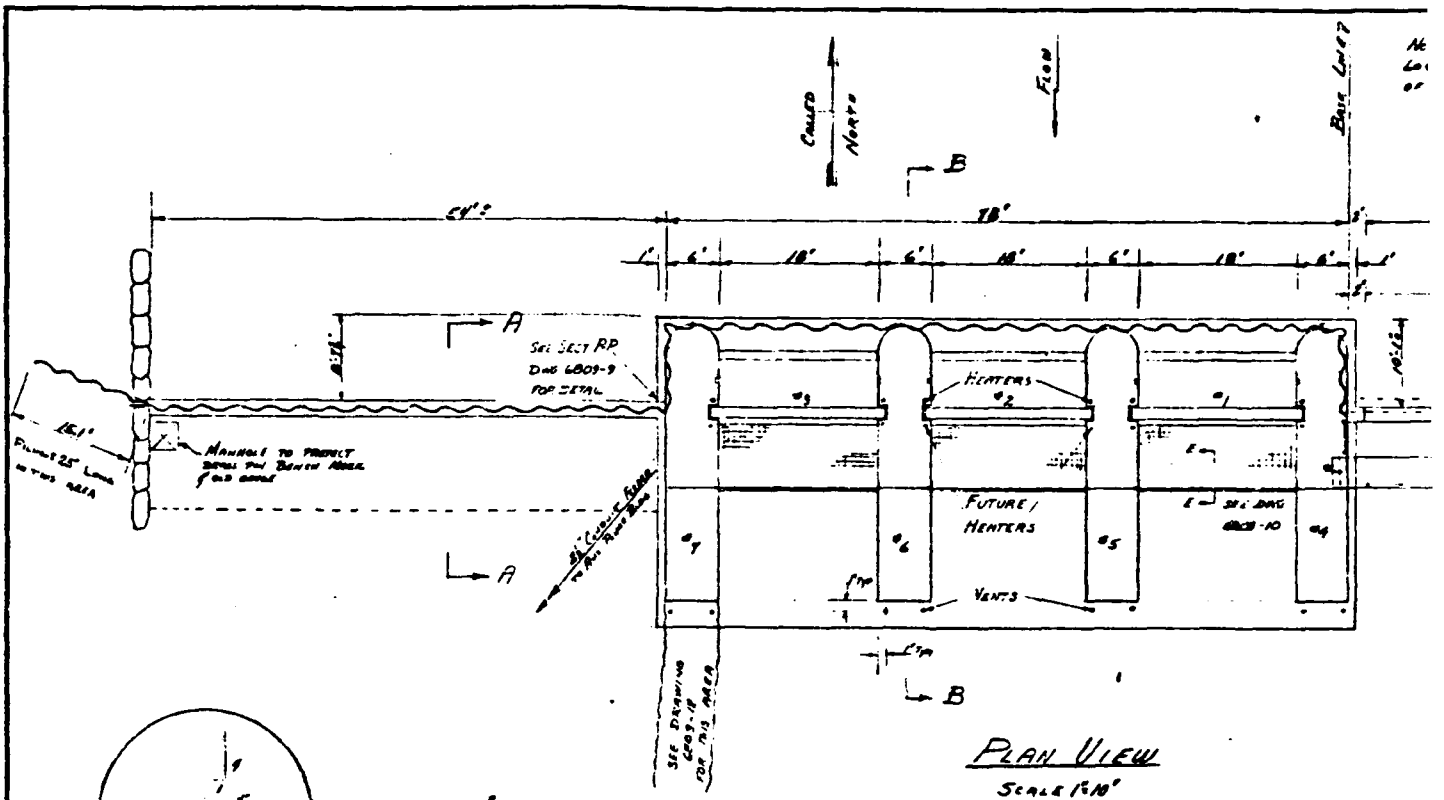


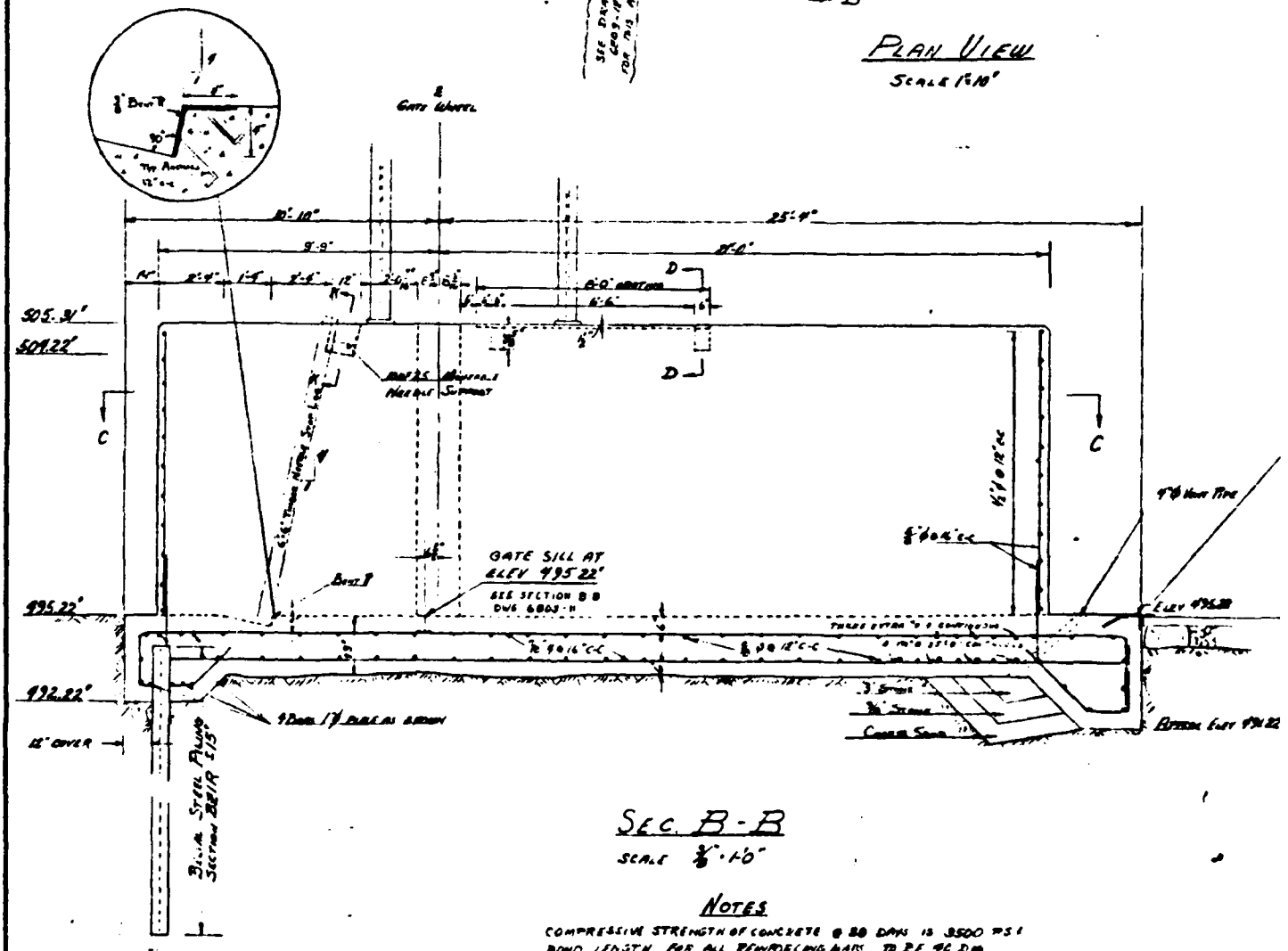
Section G-G



Section D-D

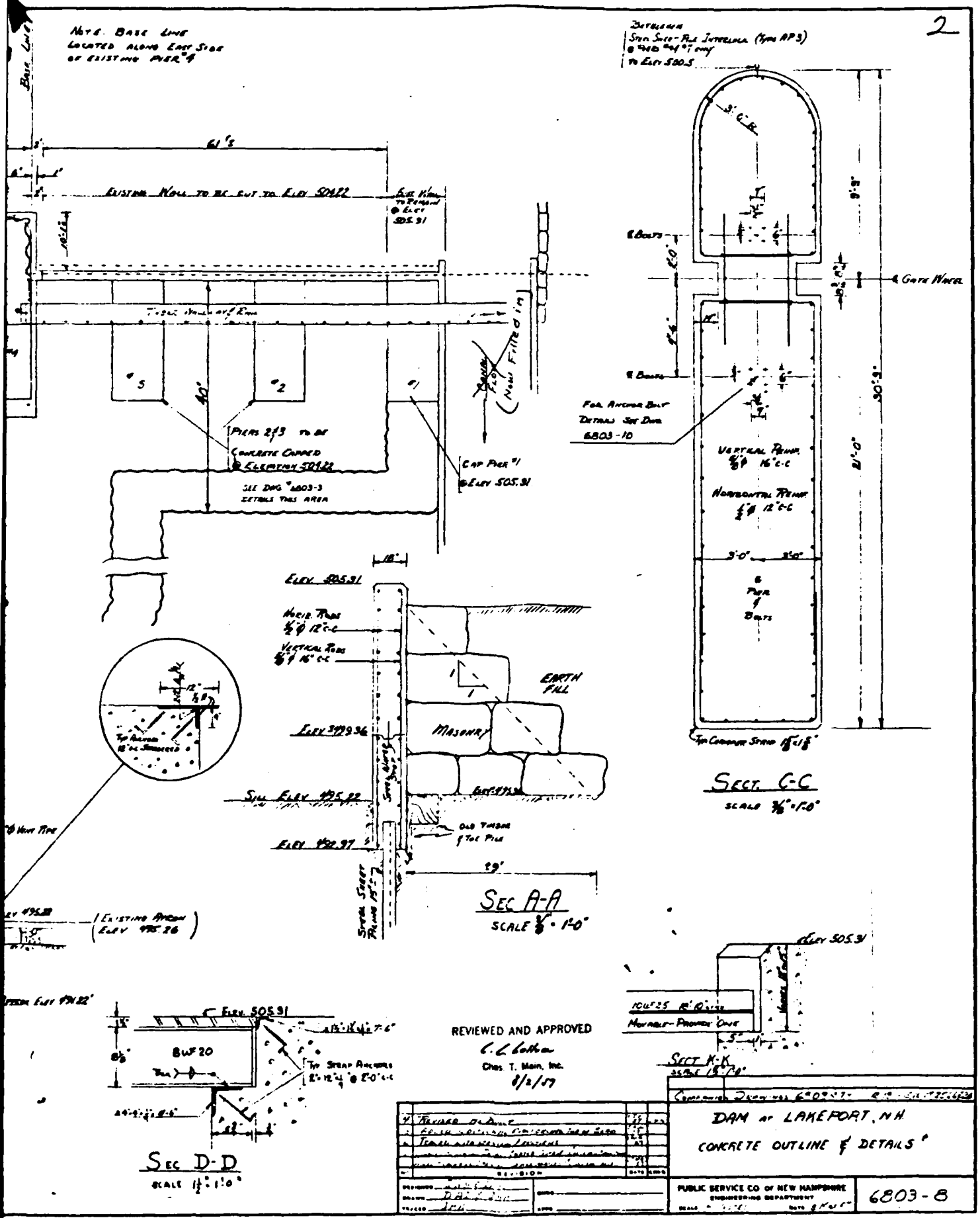
		Dam at Lakeport N.H. Showing Conditions Dec 56 Plan & Sections
DESIGNED	LINES	PUBLIC SERVICE CO. OF NEW HAMPSHIRE ENGINEERING DEPARTMENT
DRAWN	APPR.	
TRACED		





Notes

COMPRESSIVE STRENGTH OF CONCRETE @ 28 DAYS IS 3500 PSI
BOND LENGTH FOR ALL REINFORCING BARS TO BE 40 DIA.
CONCRETE COVER ON ALL REINFORCING TO BE 3" MIN UNLESS OTHERWISE NOTED
CHECK ALL ELECTRICAL DRAWINGS FOR EMBEDDED MATERIAL



4	REVISED DRAWING	
3	REVISED DRAWING	
2	REVISED DRAWING	
1	REVISED DRAWING	
NO.	DESCRIPTION	DATE

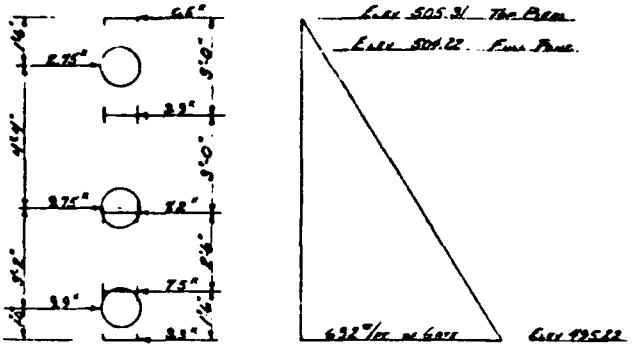
DESIGNED
DRAWN DAS
TRACED
CHECKED
QUANT.
CHECK

DAM at LAKEPORT, N.H.

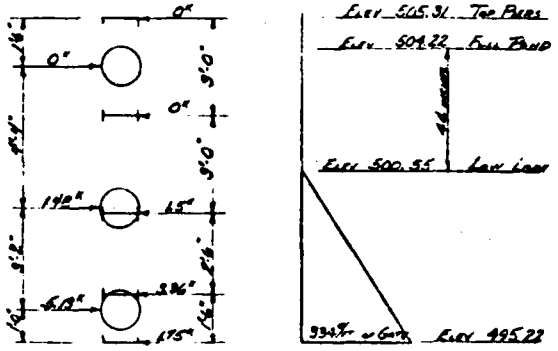
CONCRETE OUTLINE & DETAILS

PUBLIC SERVICE CO OF NEW HAMPSHIRE
ENGINEERING DEPARTMENT
SCALE 1" = 1'-0"
DATE 8 MAY 57

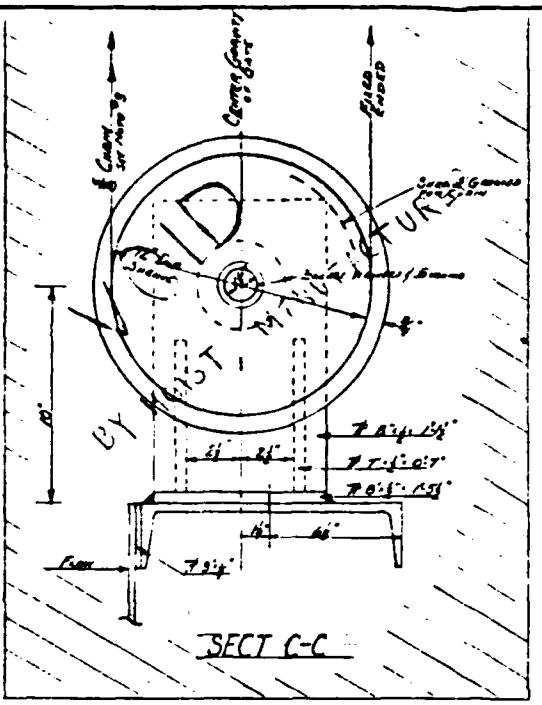
6803-8

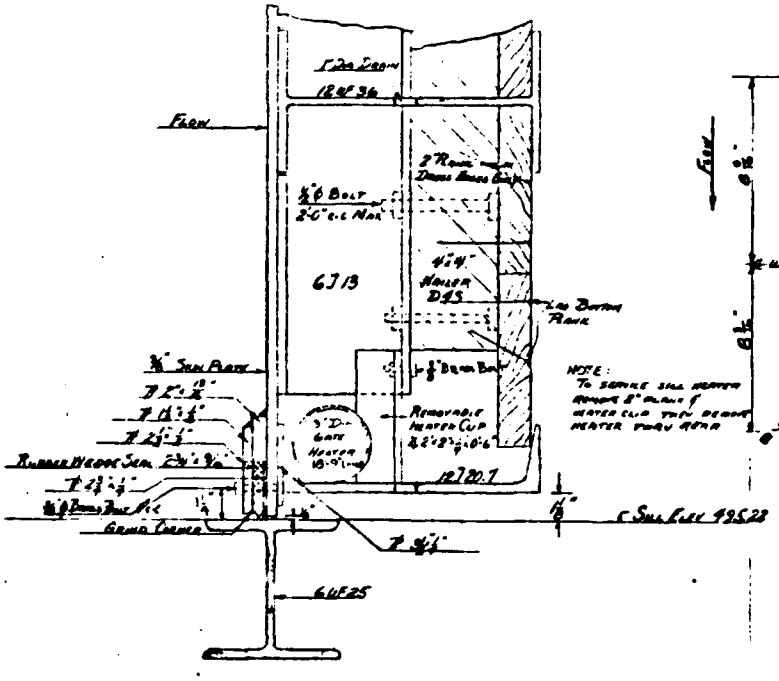


LOADING DIAGRAM
FULL POND

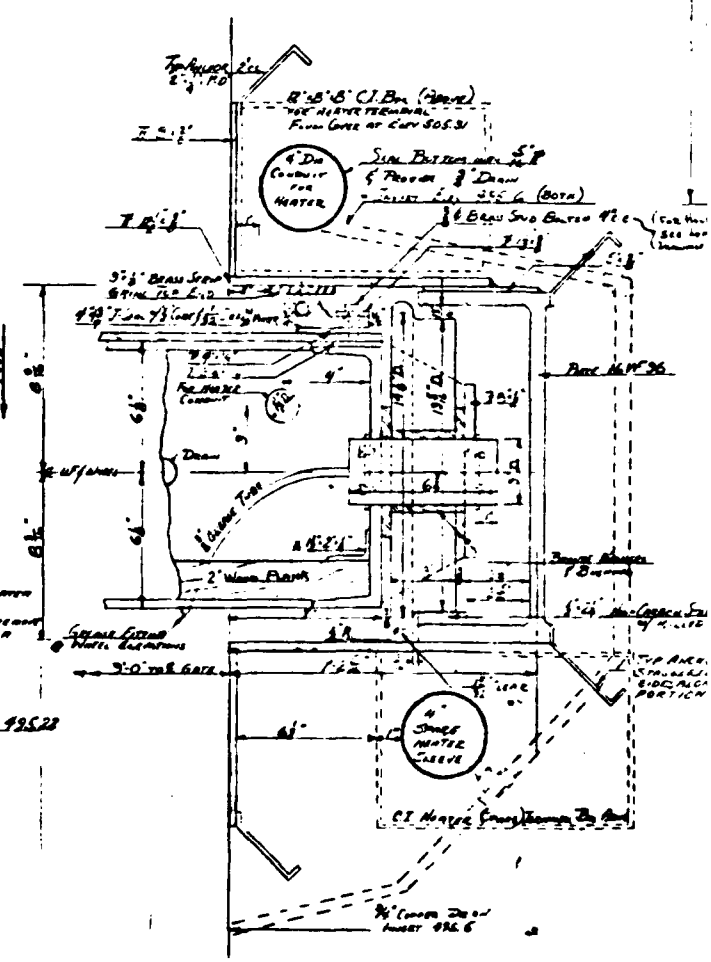


LOADING DIAGRAM
LOW LAKE

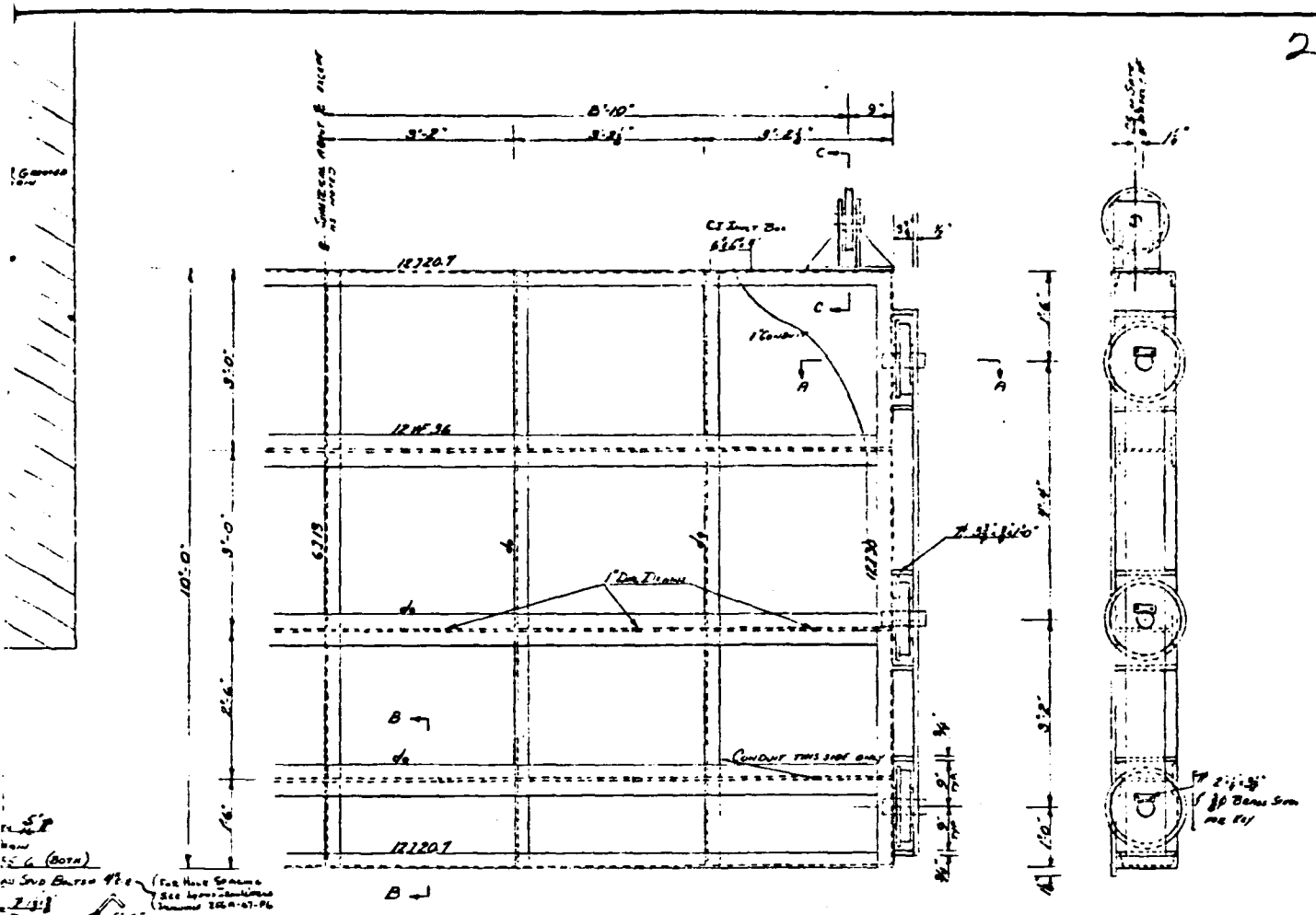




SECT B-B

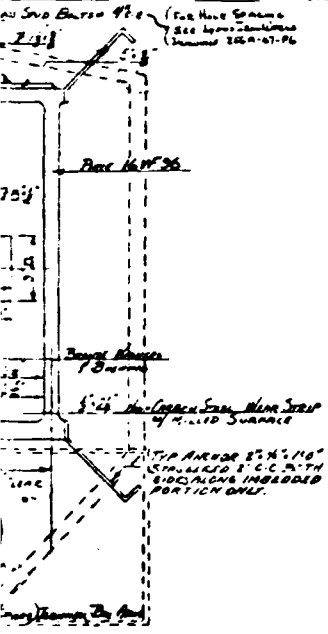


SECT A-A



HALF ELEVATION
WITHOUT ⅜" SKIN PLATE

SIDE ELEV



NOTES

1. Allowable stress in all structural members is 20,000 psi
2. All shop connections to be welded
3. Hoisting chain to be ⅝" RCCO Endurance "125 or equal & to be galvanized (Domestic Cable used)
4. Rubber seals to be similar to those manufactured by Gates Rubber Co.
5. Gate wheels to be rim bearing wrought steel 13⅜" dia. at tread
6. Lifting rate of gate to be ~~approx 4 ft~~ 10" per minute.
7. Gate operation in both up & down directions to be by a jogging switch only
8. Operator must depress a switch for an increment of the gate after selecting direction of travel
9. Maximum opening of gate to be 10'-0" and controlled by a limit device as Elec S15.40
10. Hoist capacity to be 10 ton
11. Hoist to have a torque limit device
12. Gate blades to be Atlas Tidevar Electric Heaters or equal
13. All electric apparatus to be water proof
14. All ferrous metal, except imbedded portions, to have one coat of Carbine Ferrox paint applied in the shop after the mill scale & rust have been thoroughly removed.

Contract Drawings 6E03-3 754-L to 17 25 26 & 28

REVIEWED AND APPROVED
C.C. Colleran
Gross T. Main, Inc.
8/3/57

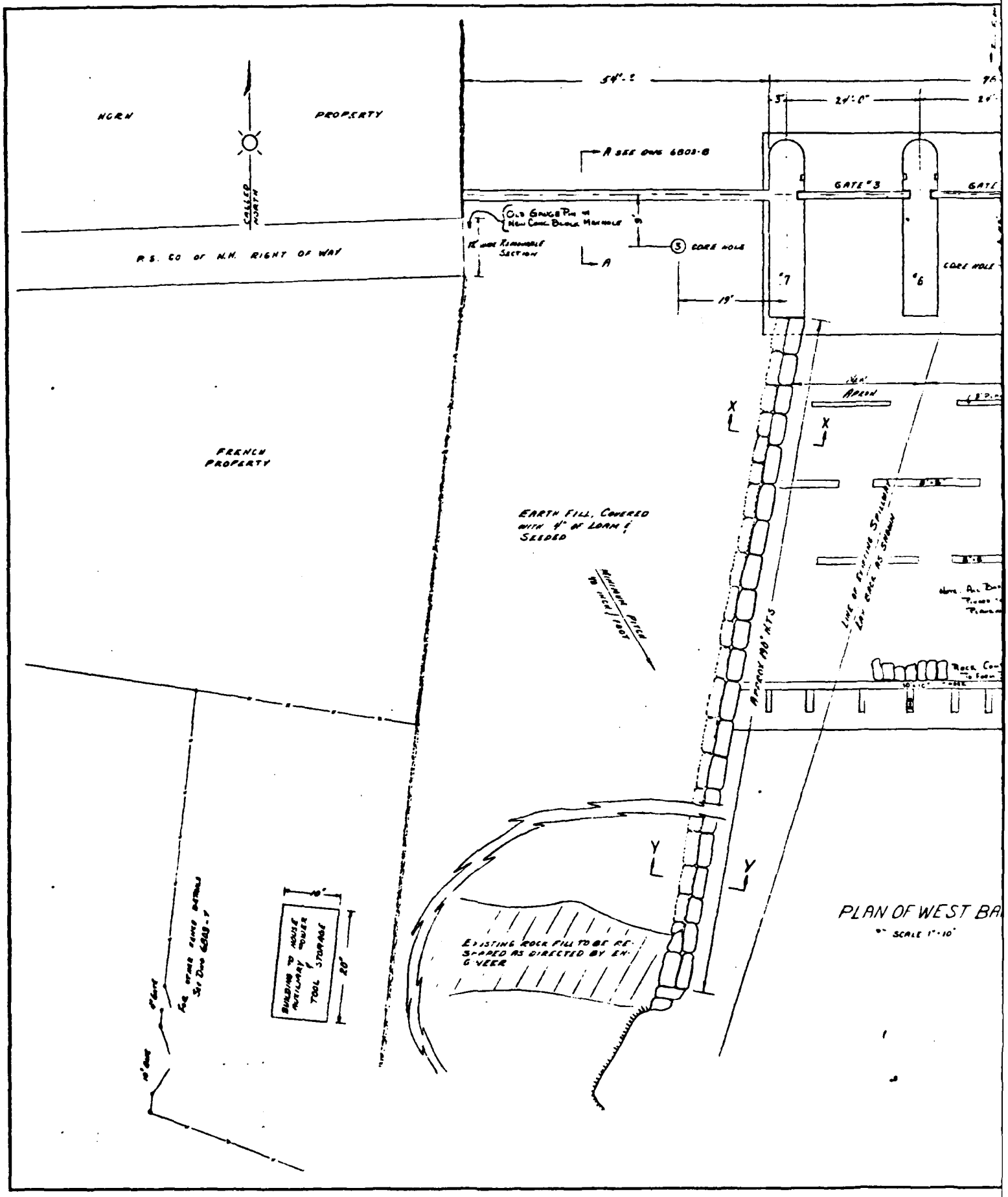
No.	REVISION	DATE	CHKD
4	Revised to Bent		
3			
2			
1			

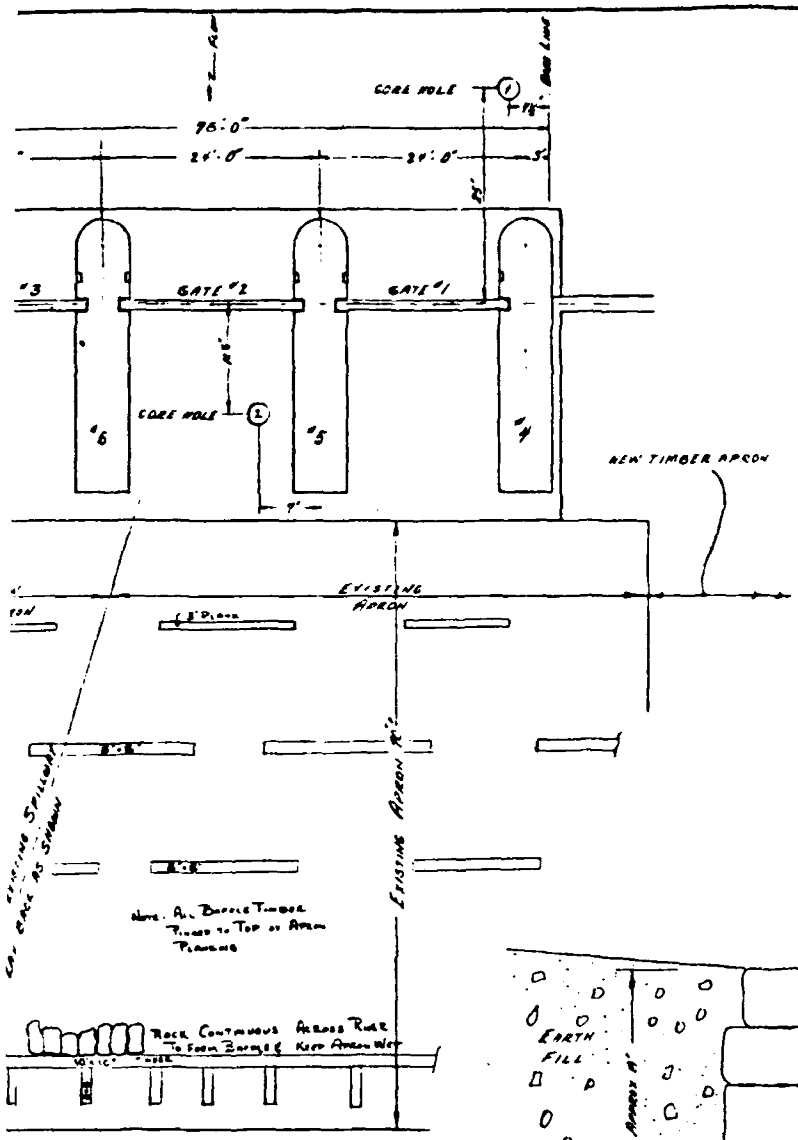
DESIGNED
DRAWN
TRACED
CHKD

DAM AT LAKEPORT, N.H.
GATE DETAILS

PUBLIC SERVICE CO OF NEW HAMPSHIRE
ENGINEERING DEPARTMENT
SCALE DATE

6E03-11

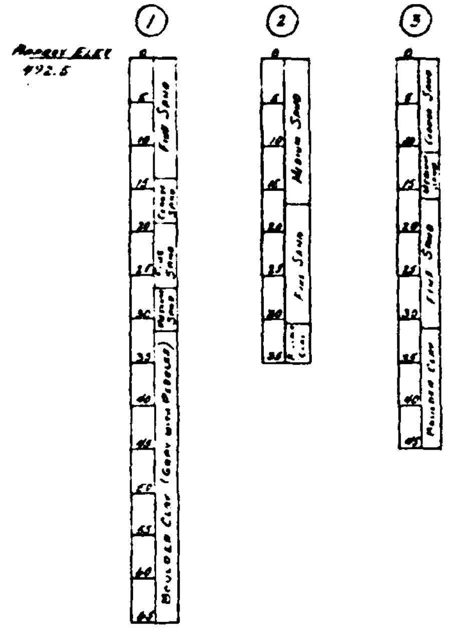

HORN
PROPERTY
CALLED NORTH
P.S. CO OF N.H. RIGHT OF WAY
FRENCH PROPERTY
54'-0"
24'-0"
A SEE DWG 6803-B
GATE #3
GATE
Old Gauge Pin in New Conc. Bridge Manhole
12" wide Removable Section
3 CORE HOLE
CORE HOLE
#7
#6
19'
A
X
X
APRON
EARTH FILL, COVERED WITH 4" of LOAM & SEEDED
APPROX 80' N.T.S.
LINE OF EXISTING SPILLWAY
Y
Y
EXISTING ROCK FILL TO BE RE-SHAPED AS DIRECTED BY ENGINEER
BUILDING TO HOUSE AUXILIARY TOOL STORAGE
10'
20'
PLAN OF WEST BA
SCALE 1"=10'

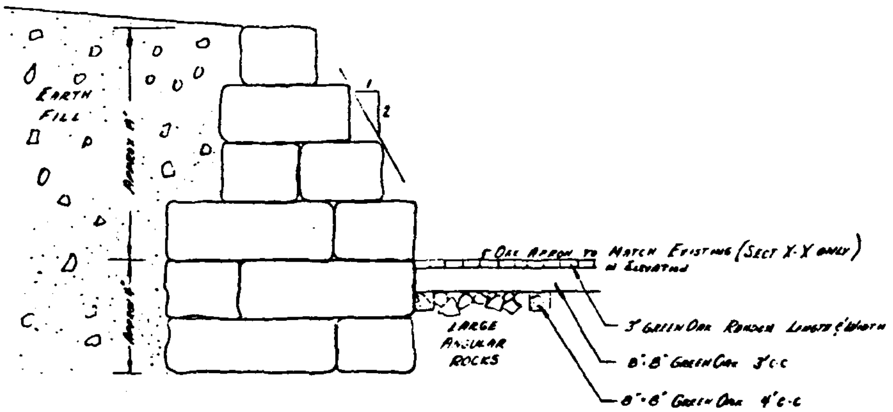


AN OF WEST BANK

SCALE 1"=10'

CORE DRILLING LOG





SECT X-X & Y-Y

SCALE 1"=3'

COMPANION DRAWINGS 6803-11, 25-26/28

REVIEWED AND APPROVED

C. C. Collum

Chas. T. Main, Inc.

8/2/57

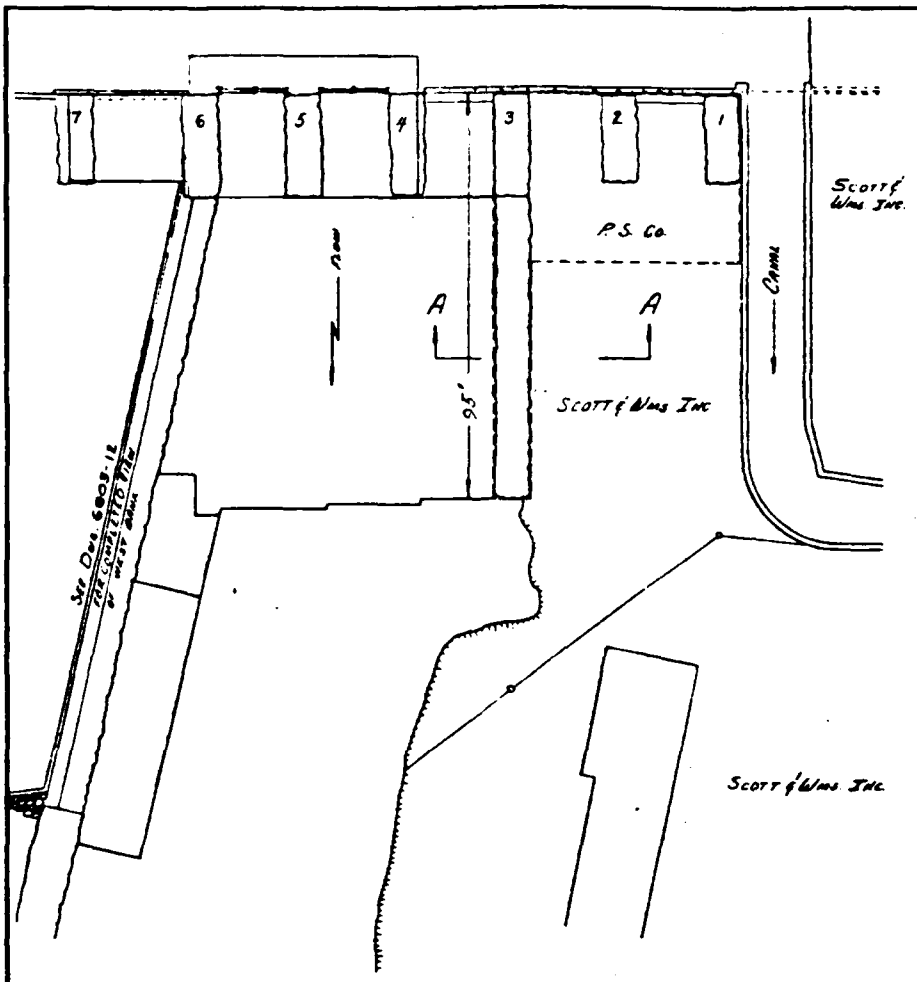
NO.	REVISION	DATE	CHKD
4	REVISED "AS BUILT"		
	TRACED WITH BORINGS FOR ALIGN		

DAM AT LAKEPORT N.H.

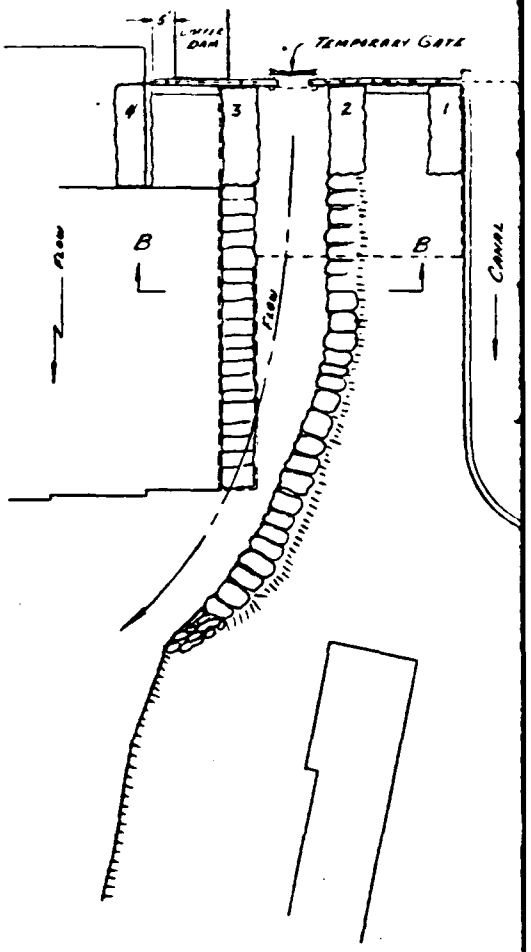
MISCELLANEOUS DETAILS

PUBLIC SERVICE CO. OF NEW HAMPSHIRE
ENGINEERING DEPARTMENT

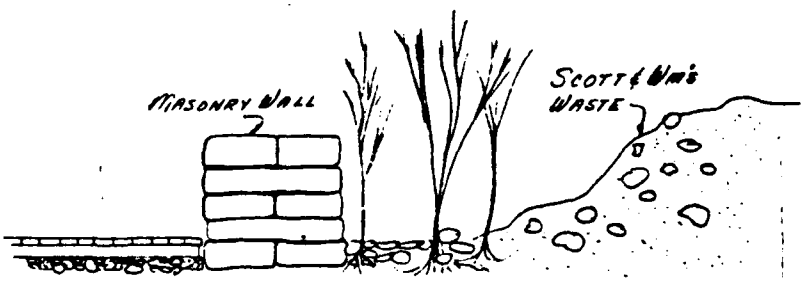
6803-12



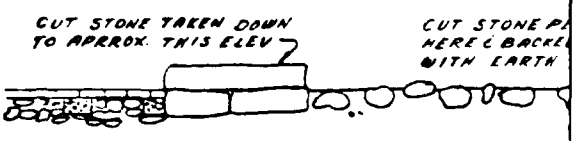
ORIGINAL PLAN VIEW
SCALE 1" = 20'



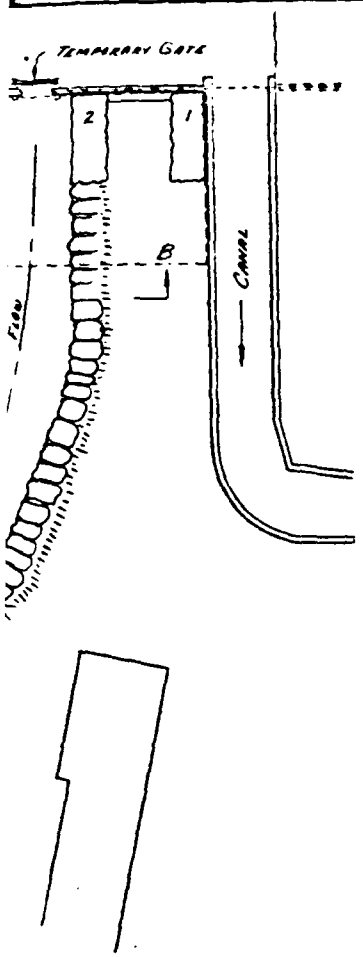
PLAN DURING CONSTRU
SCALE 1" = 20'

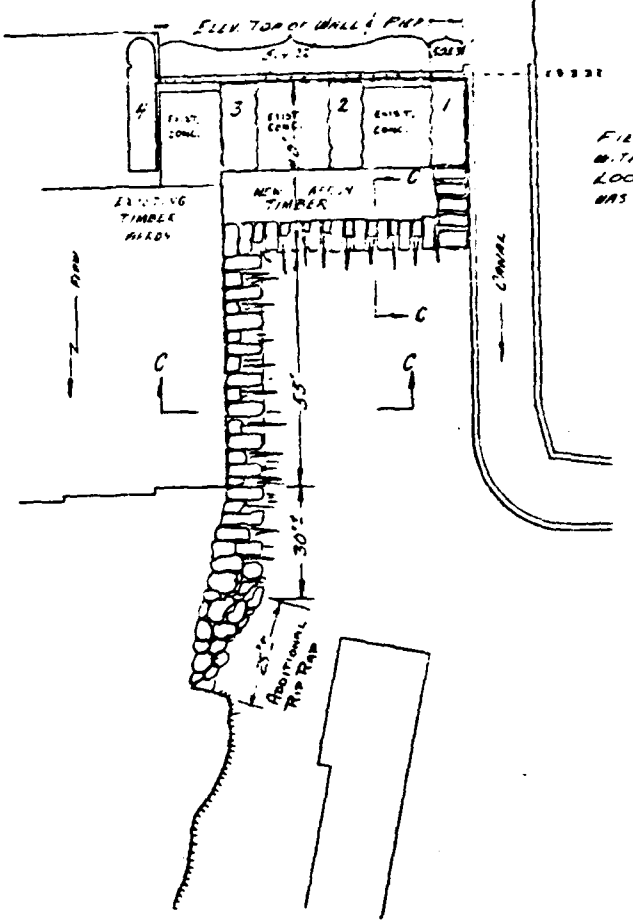


SECT. A-A
SCALE 1" = 5'



SECT. B-B
SCALE 1" = 5'

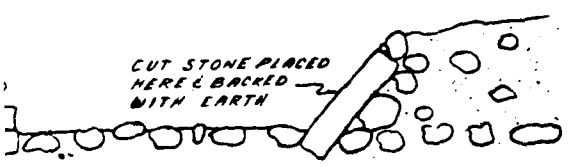




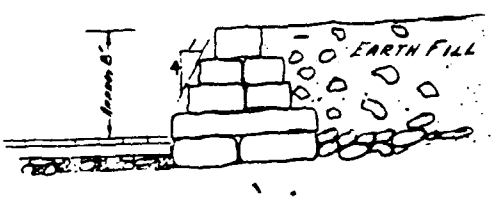
FILES 1, 2 & 3 CAPPED WITH CONCRETE AFTER LOOSE MATERIAL HAS BEEN REMOVED

DURING CONSTRUCTION
SCALE 1"=20'

COMPLETED PLAN VIEW
SCALE 1"=20'



SECT. B-B
SCALE 1"=5'



SECT C-C
SCALE 1"=5'

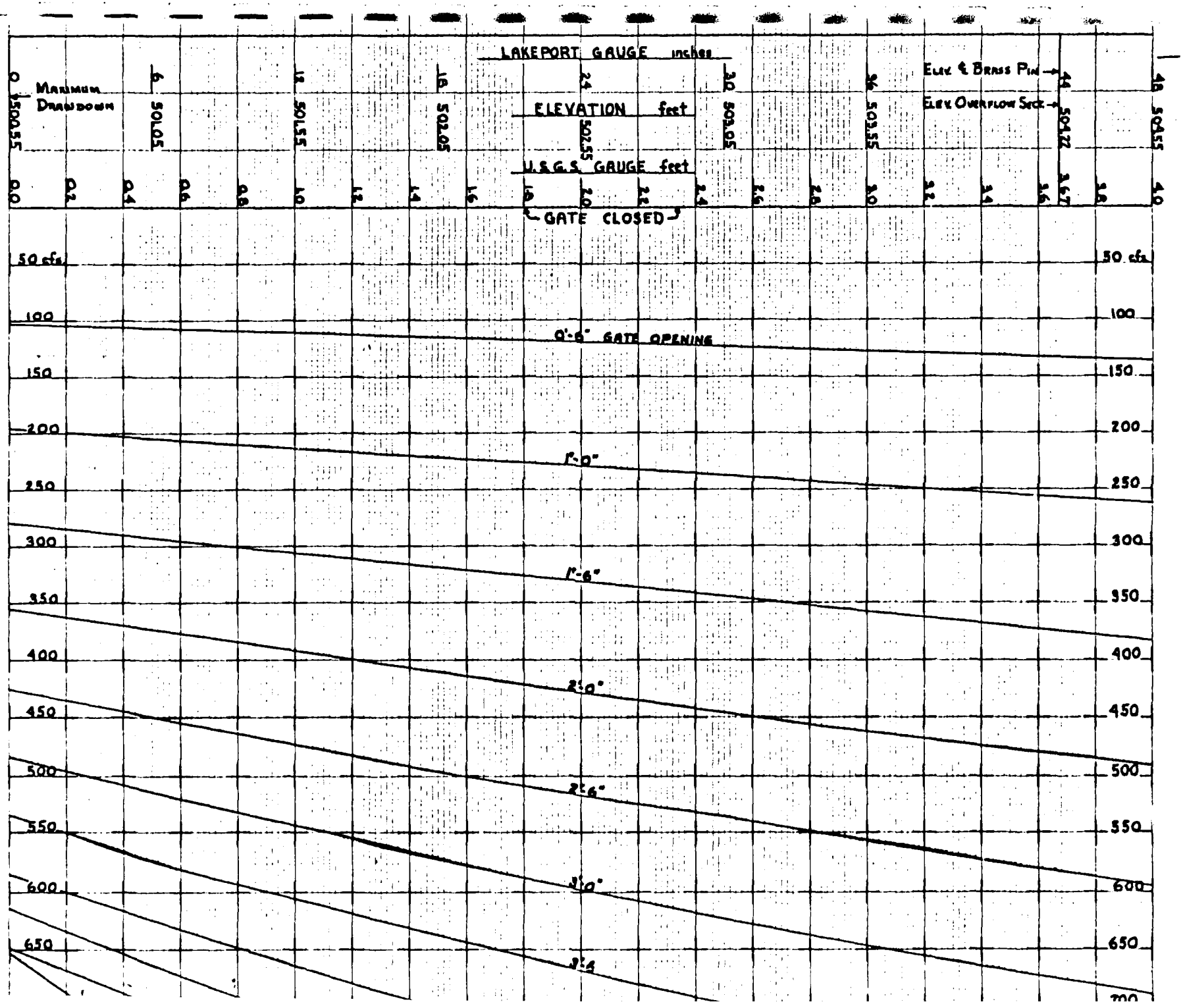
COMPANION DRAWINGS 6803-7, 8, 9, 10, 11, 12, 13 & 15 IN FILE 72

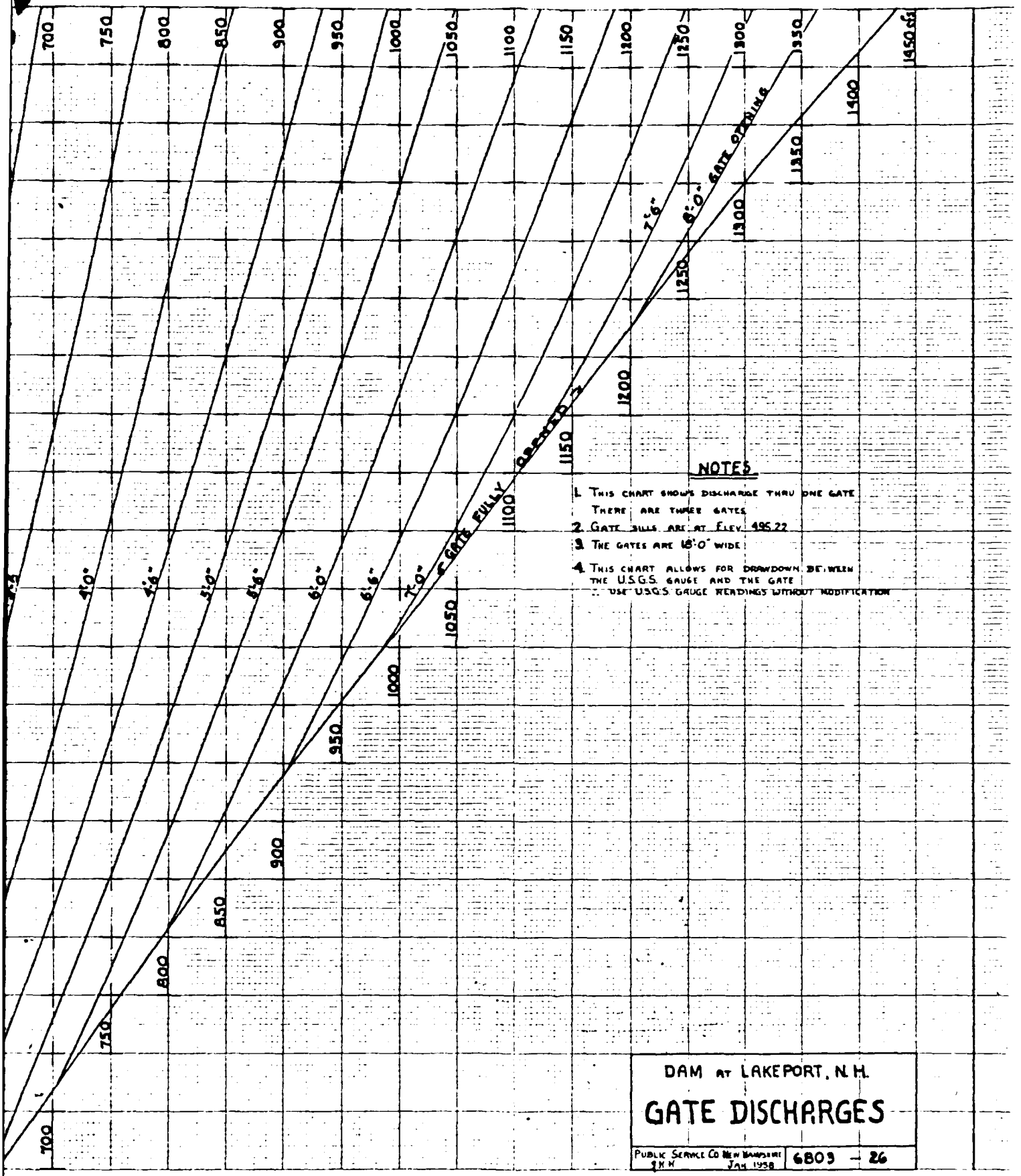
REVIEWED AND APPROVED
C. C. Gillon
Chas. T. Main, Inc.
8/2/57

DAM AT LAKEPORT, N.H.
CONSTRUCTION
ON EAST BANK OF RIVER

PUBLIC SERVICE CO OF NEW HAMPSHIRE
ENGINEERING DEPARTMENT

6803-3


LAKEPORT GAUGE inches
0
6
12
18
24
30
36
42
48
Maximum Drawdown
ELEVATION feet
501.55
502.05
502.55
503.05
503.55
504.22
504.55
U.S.G.S. GAUGE feet
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.67
4.0
Elev. & Brass Pin
Elev. Overflow Sect.
GATE CLOSED
50 cfs
100
150
200
250
300
350
400
450
500
550
600
650
700
0'-6" GATE OPENING
1'-0"
1'-6"
2'-0"
2'-6"
3'-0"
3'-6"
DISCHARGE c.f.s.



NOTES

1. This chart shows discharge thru one gate. There are three gates.
2. Gate sills are at Elev. 495.22
3. The gates are 18'-0" wide.
4. This chart allows for drawdown between the U.S.G.S. gauge and the gate. ∴ use U.S.G.S. gauge readings without modification.

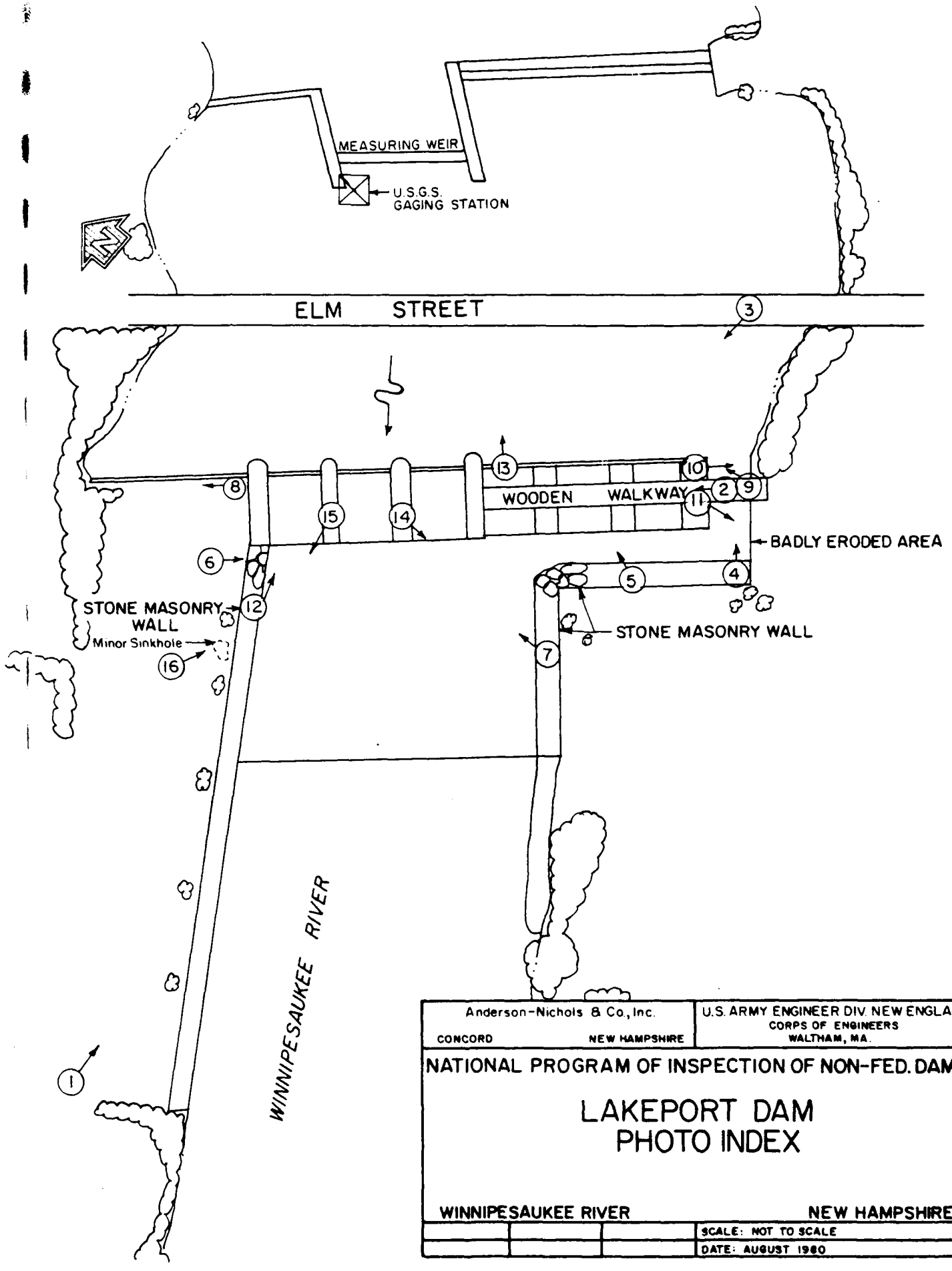
DAM AT LAKEPORT, N.H.

GATE DISCHARGES

Public Service Co New Hampshire GHH Jan 1958	6803 — 26

APPENDIX C

PHOTOGRAPHS



Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKEPORT DAM
PHOTO INDEX

WINNIPESAUKEE RIVER NEW HAMPSHIRE

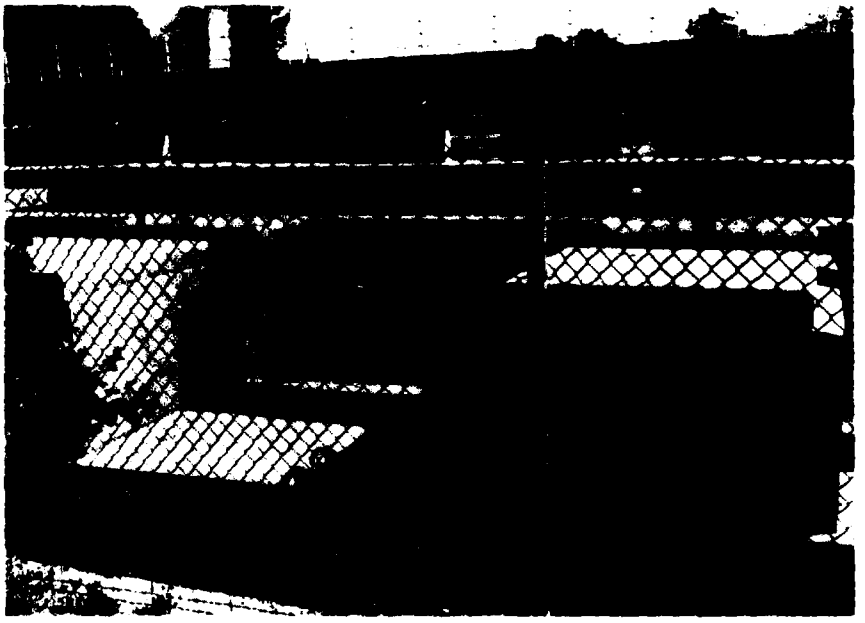
SCALE: NOT TO SCALE

DATE: AUGUST 1980

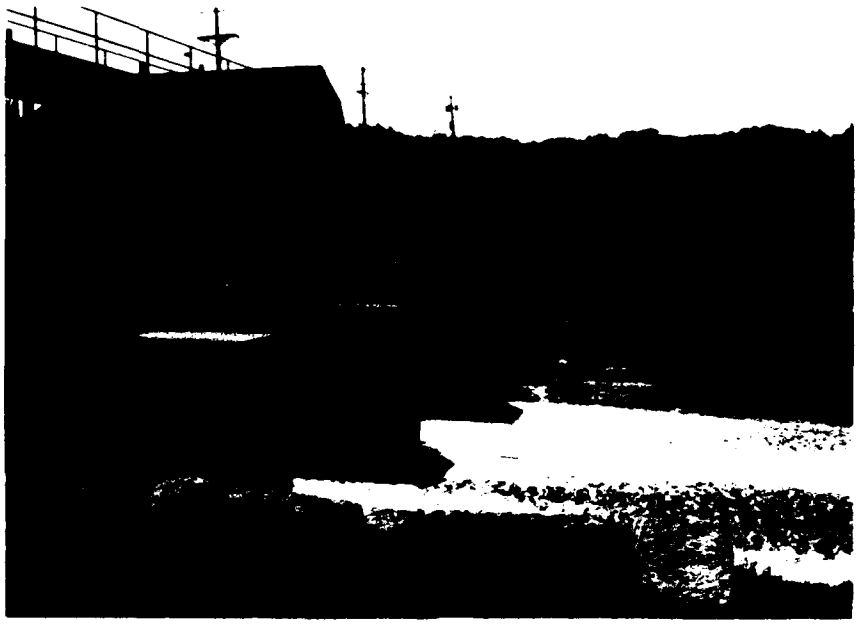
July 9 , 1980
Photo 2 - Looking across the crest of the dam from the southeast abutment.

July 9 , 1980
Photo 3 - View of the upstream face of the dam from the Elm Street Bridge.

July 9, 1980
Photo 4 - Looking at the stoplog spillway structure.



July 9, 1980
Photo 5 - View of the downstream face of the overflow spillway.



July 9, 1980
Photo 6 - View of the downstream face of the dam from the northwest abutment. Note the side channel at the far end of dam.

July 9 , 1980
Photo 7 - Looking at the gated section of the dam.

July 9, 1980
Photo 8 - Looking at the northwest abutment.

July 9, 1980
Photo 9 - View of the surface spalling on the intake channel to the stoplog spillway.

July 9, 1980

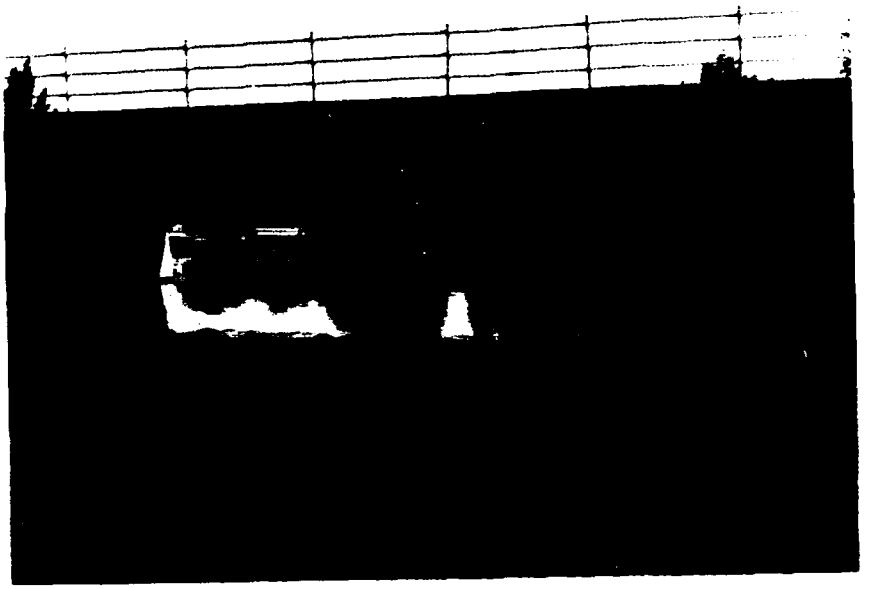
Photo 10 - View of the surface spalling on the southeast end of the intake channel to the stoplog spillway.

July 9, 1980

Photo 11 - View of the eroded area on the downstream southeast abutment training wall.

July 9, 1980

Photo 12 - Looking at the downstream side of the gate structure nearest the northwest abutment. Note leakage around end of gate.



July 9, 1980

Photo 13 - Looking upstream from the crest of the dam.

July 9 , 1980
Photo 14 - Looking at the southeast downstream channel masonry wall.

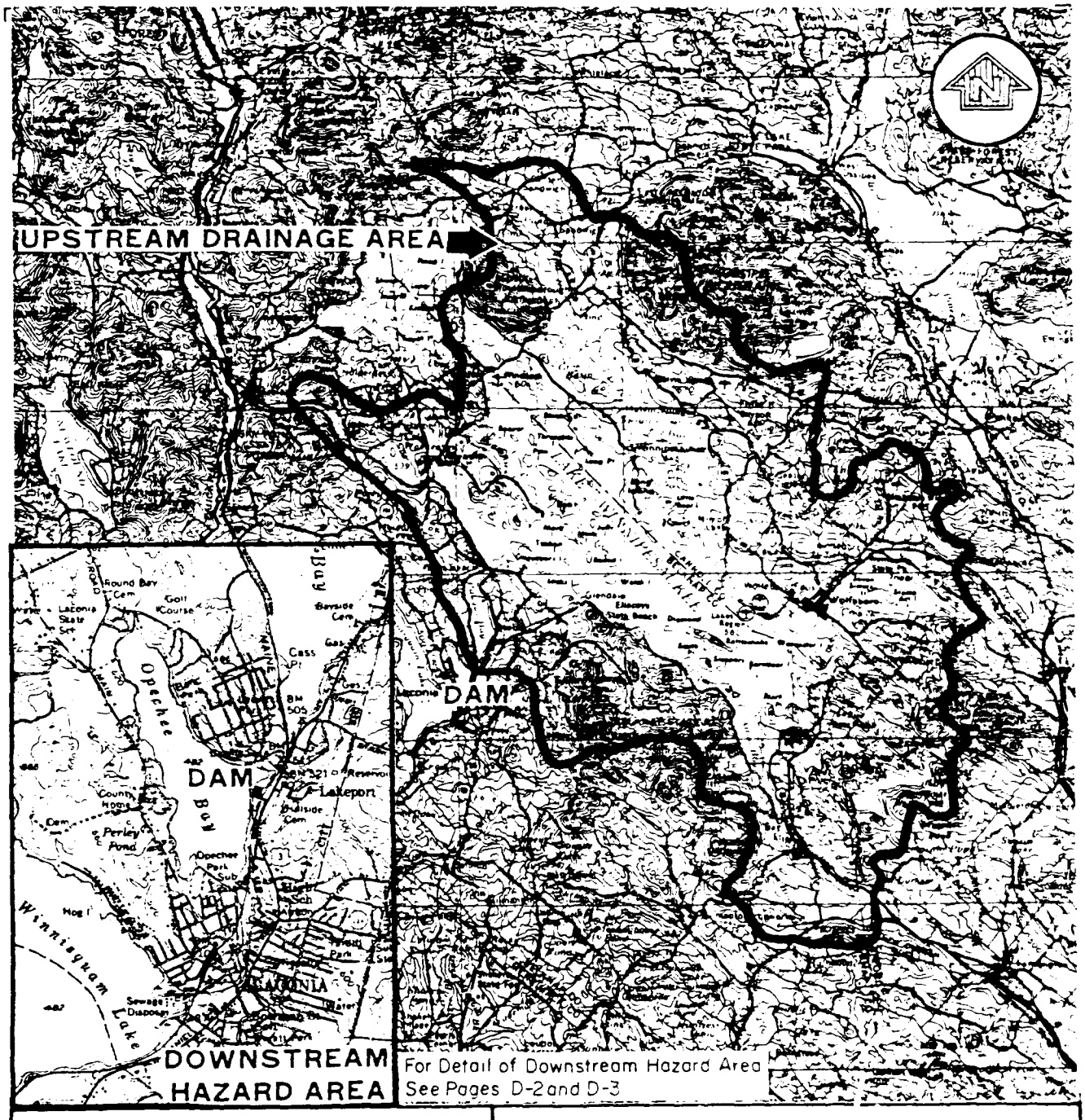
July 9 , 1980
Photo 15 - Looking at the northwest downstream channel masonry wall.

July 9, 1980

Photo 16 - View of the sinkhole noted in the fill behind the training wall on the northwest side of the discharge channel.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LAKEPORT DAM
LACONIA, NEW HAMPSHIRE

REGIONAL VICINITY MAP

AUGUST 1980

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

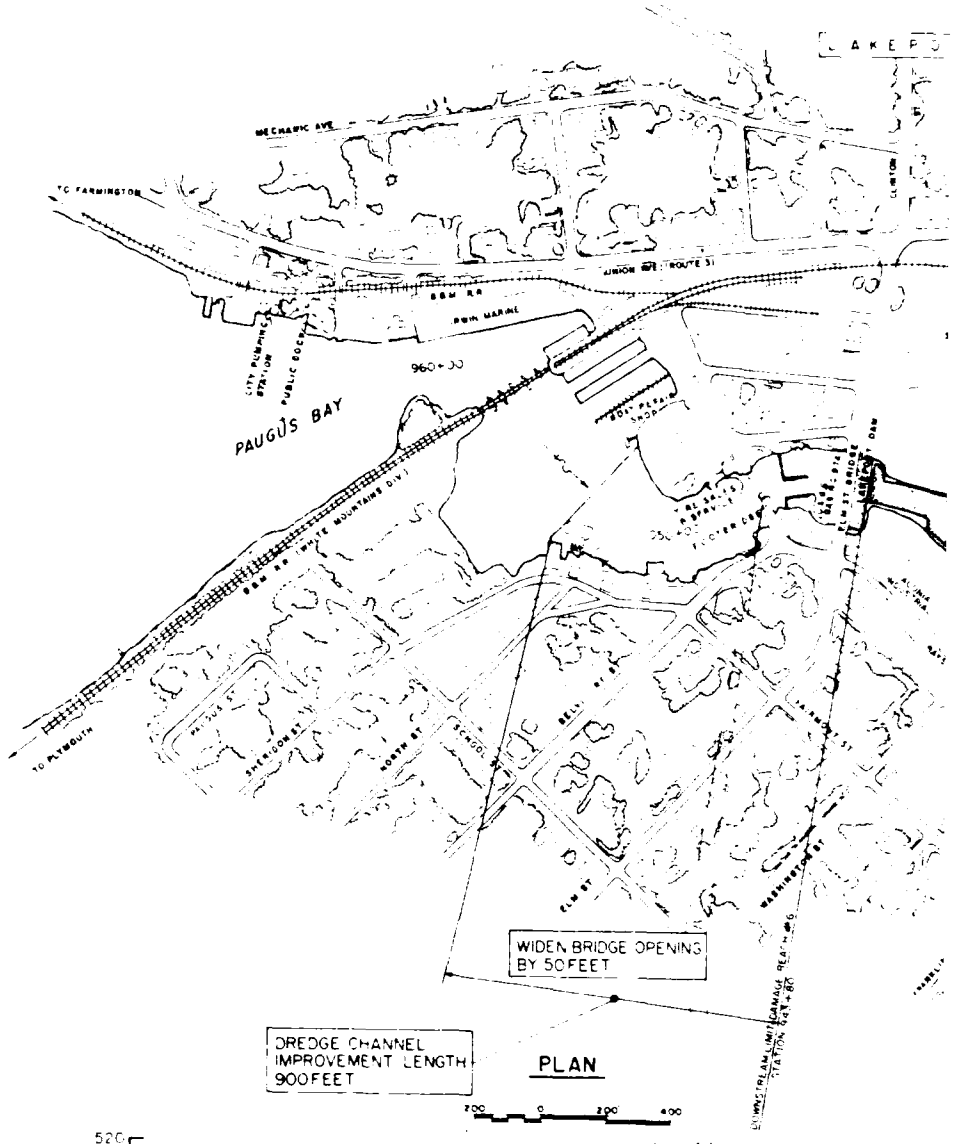
ANDERSON-NICHOLS & CO., INC. CONCORD, N.H

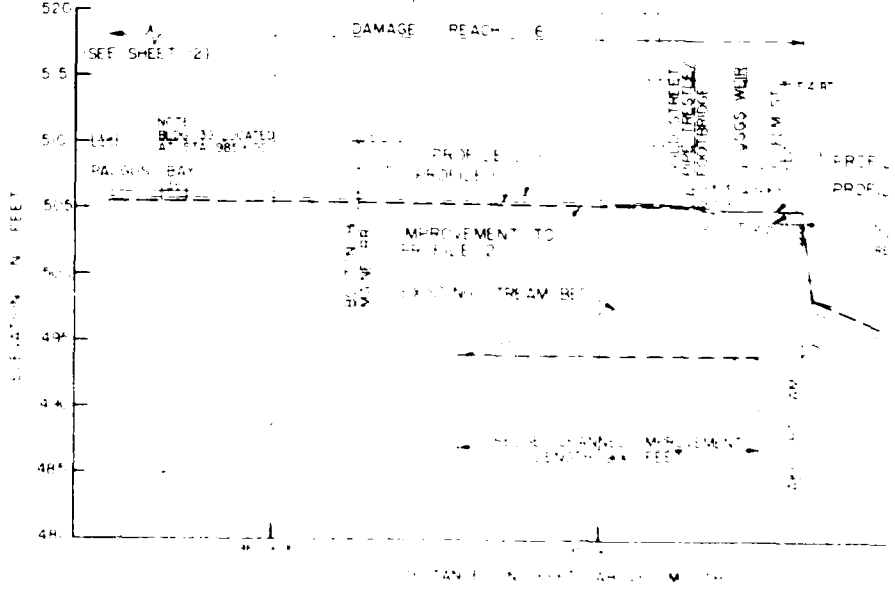
SCALE IN MILES

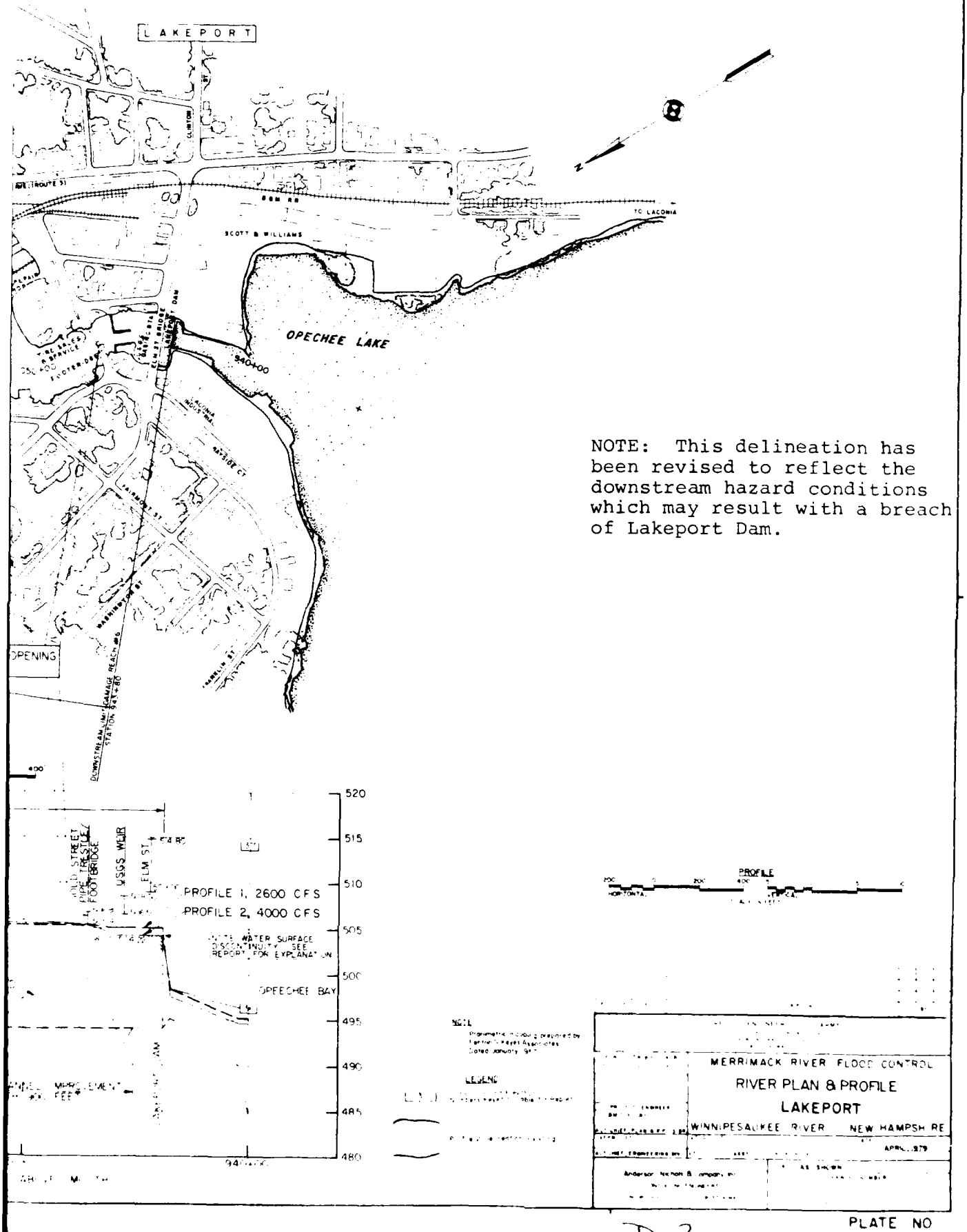
0 5 10

MAP BASED ON U.S.G.S. 1:250,000 SERIES TOPOGRAPHIC MAPPING. NK19-1 PORTLAND, ME, N.H. 1956 REVISED 1972.

CORPS OF ENGINEERS





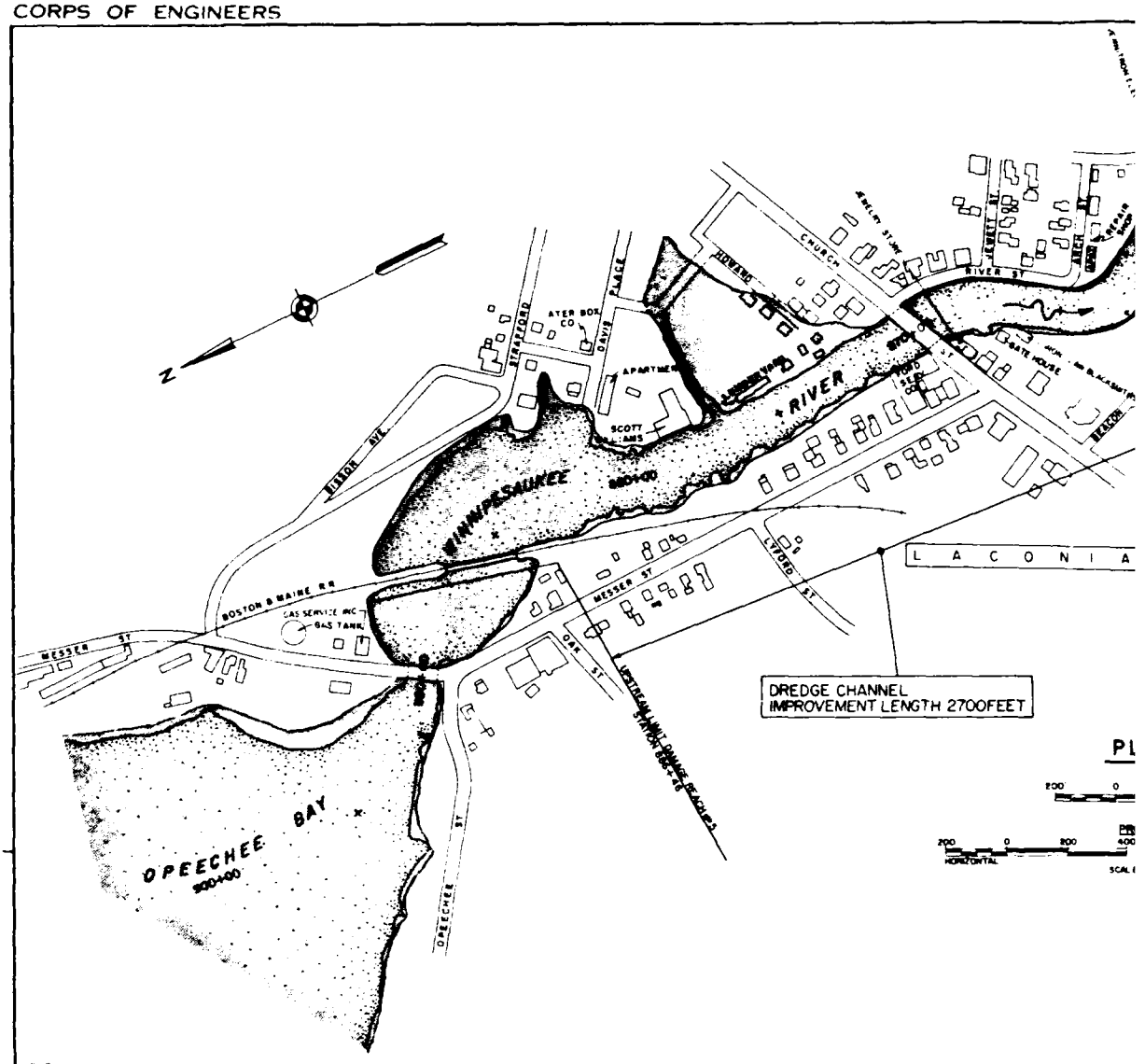


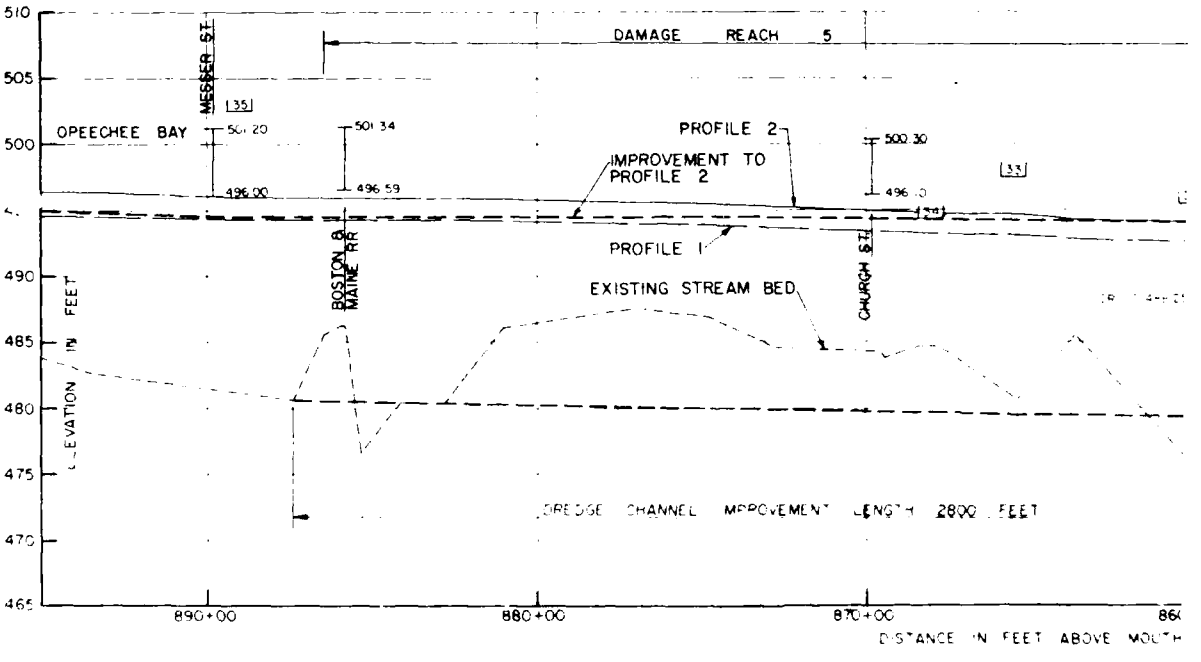
NOTE: This delineation has been revised to reflect the downstream hazard conditions which may result with a breach of Lakeport Dam.

D-2

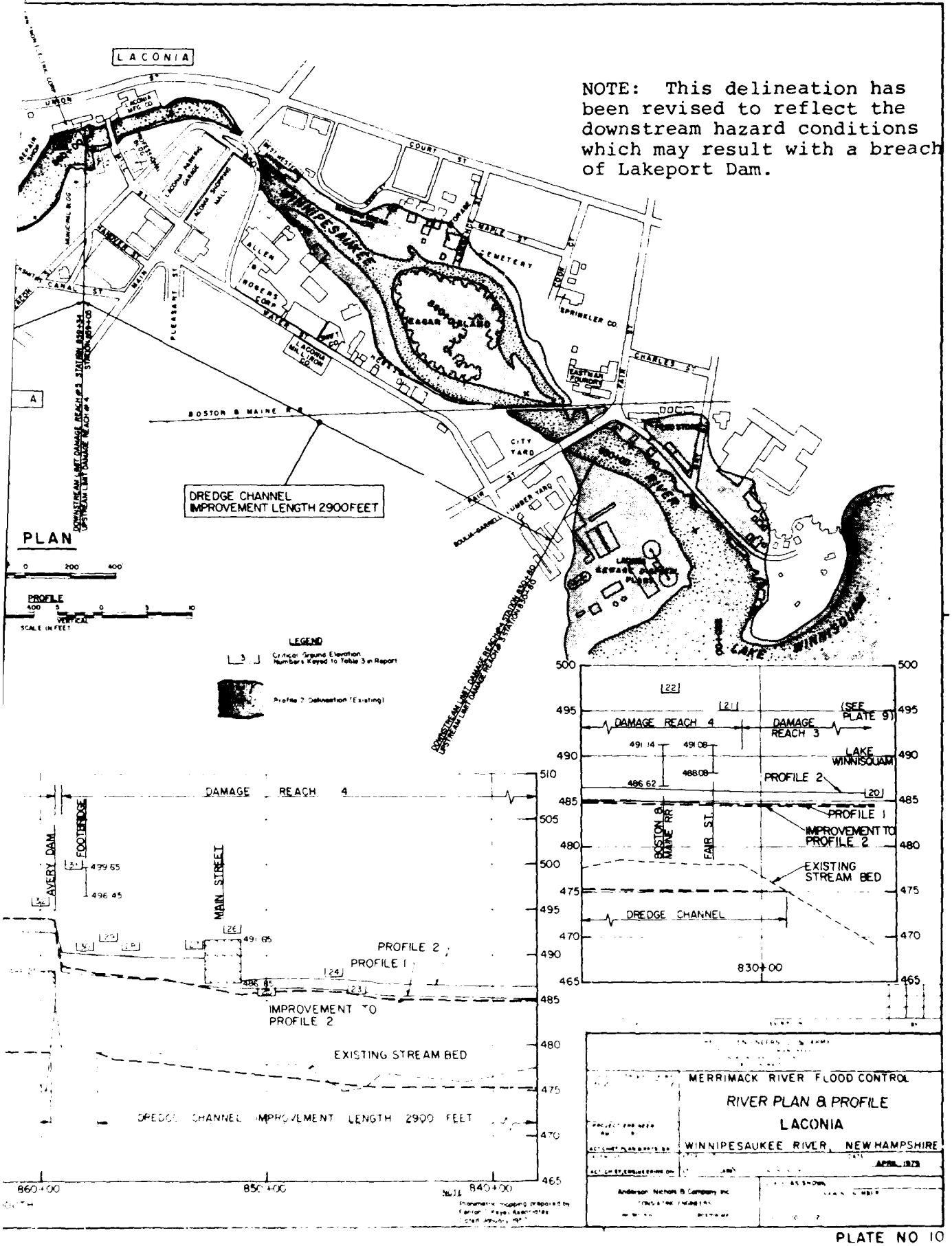
PLATE NO

CORPS OF ENGINEERS





U. S. ARMY



MERRIMACK RIVER FLOOD CONTROL

RIVER PLAN & PROFILE

LACONIA

WINNIPESAUKEE RIVER, NEW HAMPSHIRE

APRIL 1979

Anderson-Nichols & Company, Inc.

PLATE NO 10

D-3

Anderson-Nichols & Company, Inc. Subject Breach Analysis

Sheet No. 1 of 2
Date 7.15.99
Computed
Checked

JOB NO. 3273-24 Lakeport Dam

BREACH ANALYSIS - Assume breach to occur with water surface at top of dam (504.32' NGVD) to determine downstream hazard potential.

Assume WSEL @ 504.32' NGVD
Downstream invert (gate section) = 495.22' NGVD
Downstream invert (spillway section) = 495.9' NGVD

$Q_E = \frac{8}{27} W_b \sqrt{g} y_o^{3/2}$ where: W_b = breach width
$g = 32.2$ ft/sec^2
y_o = depth at breach

Breach could be assumed to occur at either the gated section (Q_{p1}) or the spillway section (Q_{p2}) of the dam.

Gated Section

$W_b = 78'$
$y_o = 504.32 - 495.22 = 9.1'$
$Q_{p1} = \frac{8}{27}(78)(\sqrt{32.2})(9.1)^{3/2}$
$Q_{p1} = \underline{3600 \text{ cfs}}$

Spillway Section

$W_b = 85'$
$y_o = 504.32 - 495.9 = 8.4'$
$Q_{p2} = \frac{8}{27}(85)(\sqrt{32.2})(8.4)^{3/2}$
$Q_{p2} = \underline{3480 \text{ cfs}} + 250 \text{ cfs} = \underline{3730 \text{ cfs}}$
↓ discharge through gated section

Assume normal operation of gates at Lakeport and normal elevation of Opechee Bay (≈ 492' NGVD). Utilizing the HEC-2 backwater runs from Reference #1 (Laconia, FIS), the 100-year profile of Q = 3,500 cfs provides a reasonable estimate of downstream damages caused by Breach Q_{p1} or Q_{p2}. A breach discharge of this magnitude could cause an increase in stage

TABLE VI-1

GAGE HEIGHTS AND CAPACITY OF LAKE WINNIPESAUKEE

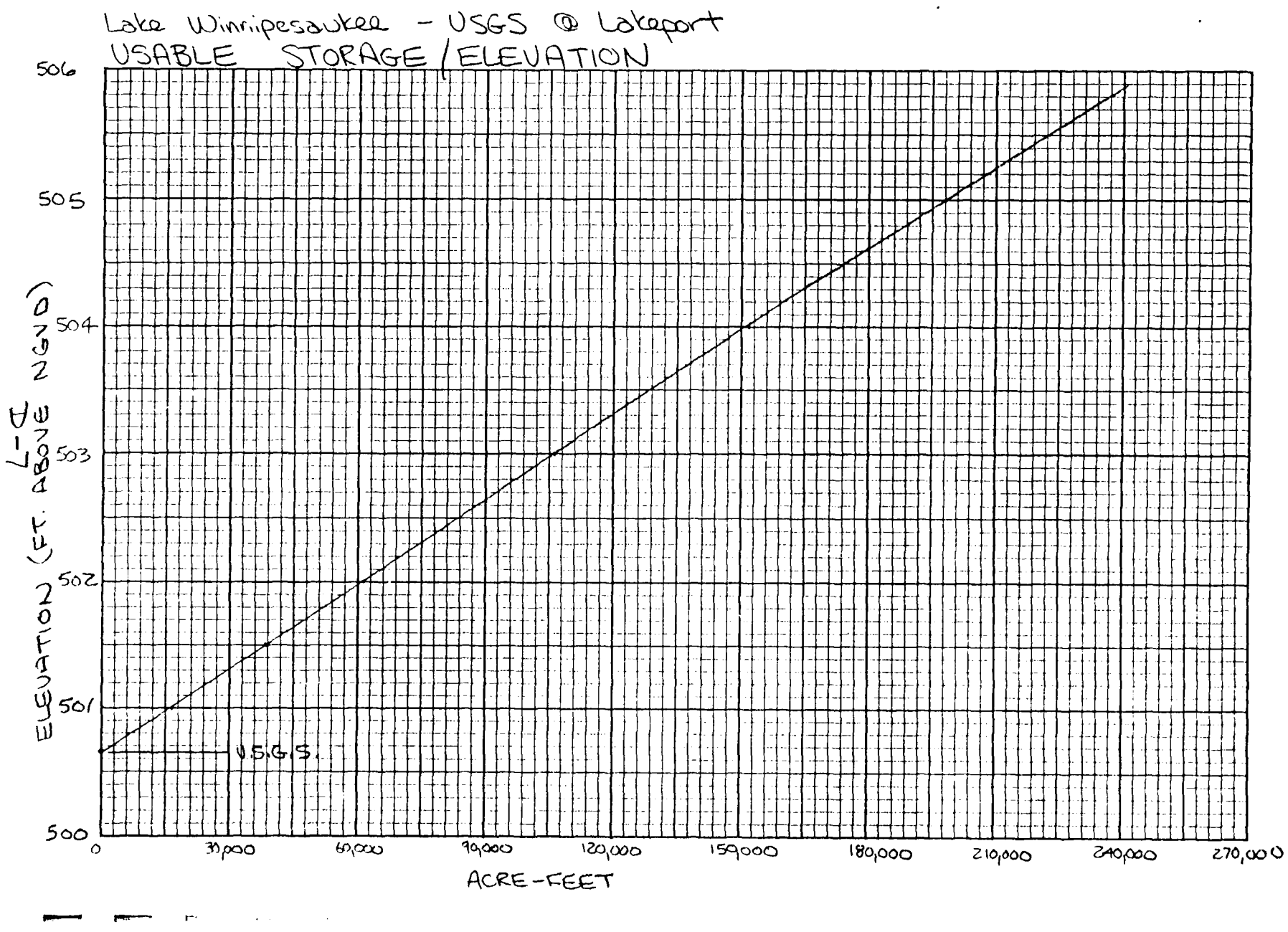
Elev. ft. above msl	Gage height feet	Capacity in millions of cubic feet	Cumulative usable capacity in millions of cubic feet acre-feet		acre-feet
505.00	5.00	19,850	455,700	*	198,100
504.32 Report Top of Dam →	4.32	(est.)* 18,440	423,300	7,220	165,800
504.00	4.00	17,840	409,550	6,620	152,000
503.00	3.00	15,840		4,620	106,100
502.00	2.00	13,880		2,660	61,100
501.50	1.50	12,900		1,680	39,600
501.00	1.00	11,930		710	16,300
500.65	0.65	(est.) 11,220		0	
500.00	0.00	10,020		--	

* Storage capacity above Elev. 504.32 ft. is temporary or surcharge storage.

The watershed of Lake Winnipesaukee is 363 square miles. Using the data contained in Figures 2-1, 2-2, and 2-3, the table below shows the estimated daily runoff. (Evaporation from the lake surface would reduce the usable portion of this runoff.)

Type	Runoff in mgd
Annual mean runoff	385
95% dry year	200
1965	175

As the Coastal Area average daily requirement in 2020 is only 140 mgd, it seems reasonable to assume that natural runoff alone would support the area's water supply requirements. At some future date, however, augmentation will become necessary. The brief analysis described below discusses augmentation from the Pemigewasset River and gives



Anderson-Nichols & Company, Inc. Subject Test Flood Analysis

Sheet No. 1 of 3
Date 7/03 00
Computed L.W. Lamie
Checked

JOB NO. 3273-24 Lakeport Dam, Laconia, N.H.

DAM : Lakeport
Drainage Area : 363 mi^2
Hydraulic Height : 504.32 − 495.22 = 9.1' } Size - Large
Storage Capacity : 165,700 ac-ft (usable) } based on Storage
D/S Hazard : High
Test Flood Range : PMF
Chosen Test Flood : PMF

Lakeport Dam controls the water level and outflow from Lake Winnipesaukee, a large recreational lake owned and controlled by the State of New Hampshire Water Resources Board (NHWRB). Numerous studies have been done on Lakeport Dam and the Lake Winnipesaukee basin. The following specific studies were evaluated and pertinent sections were utilized in the compilation of data significant to this report:

Ref. 1. Laconia, N.H. Flood Insurance Study (FIS) performed by Anderson-Nichols & Co., Inc., Concord, N.H., 1978.

Ref. 2. "Lakeport Dam, Inspection and Analysis Report", July 1978, by Chas. T. Main, Inc., Boston, Mass.

Ref. 3. "Hydraulic Engineering Analysis for Evaluating Flood Stage Reduction on the Winnipesaukee River, New Hampshire", 1978, by Anderson-Nichols & Co., Inc., Concord, N.H.

In addition to these studies, additional data and information was obtained from the files of the NHWRB.

A cross section follows which defines the pertinent features and elevations of the dam.

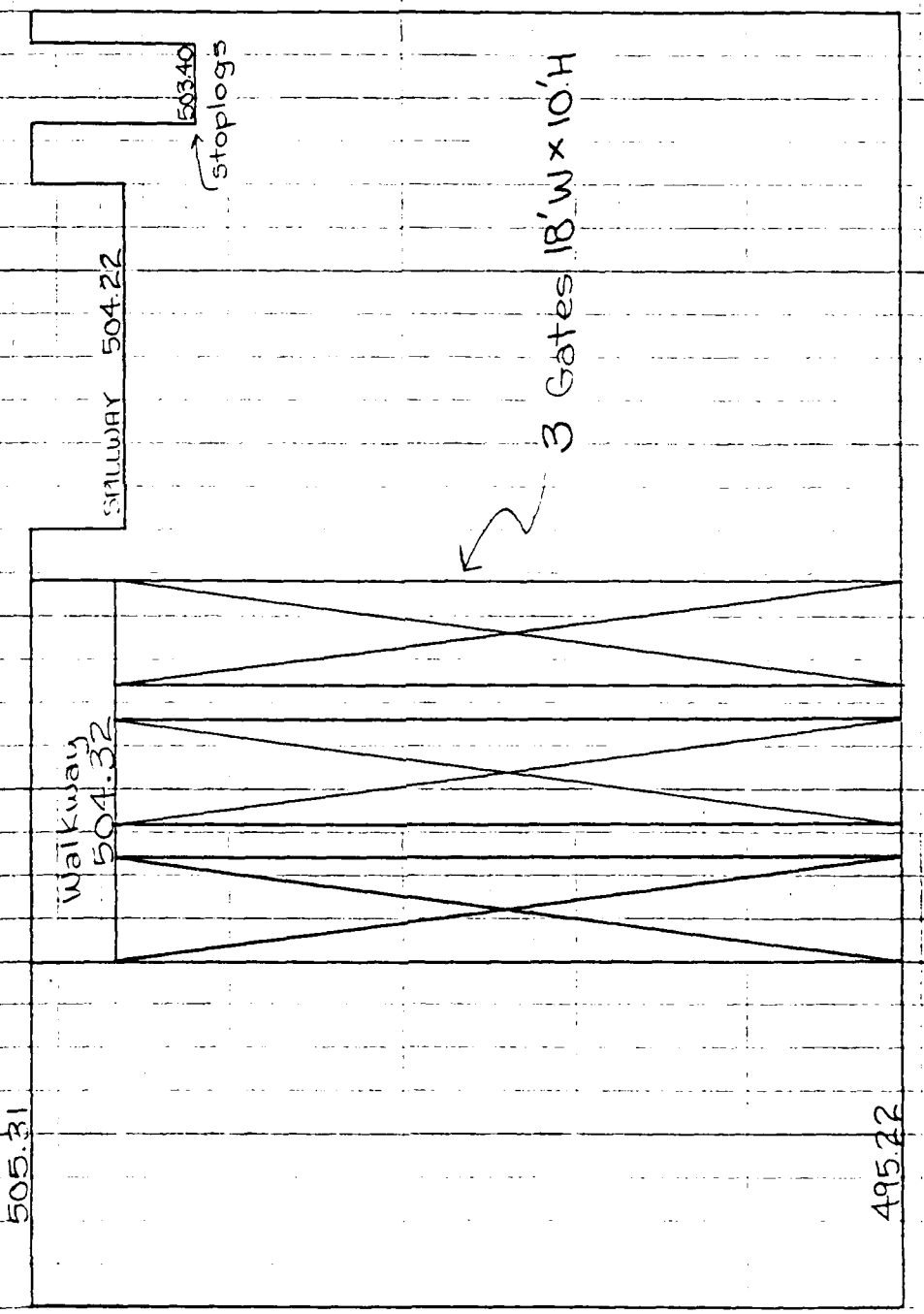
Anderson-Nichols & Company, Inc.

JOB NO. 3273-24

Subject Cross Section
Lakeport Dam

Sheet No. 2 of 3
Date 7/03/80
Computed L.W.Williams
Checked

Cross section of existing Lakeport Dam from downstream looking upstream.



SQUARES 1/4 IN. SCALE

The PMF analysis performed in Reference 2, performed by Chas.T. Main in July 1978, was evaluated for use in this report. After examination of the backup, it was determined that the analysis was a detailed study of the basin and probably reflects more accurately the actual basin characteristics than that which would be performed in a Phase I analysis using the COE "guide curves". The study was reviewed and the results deemed reasonable. Concurrence was given by the Corps for use of this PMF analysis in this Phase I inspection report.

Following is the complete H/H appendix as seen in the Chas T. Main study.

Backup taken from:
"Lakeport Dam, Inspection and Analysis Report", July 1978, by Chas T. Main

HYDROLOGY

Any catchment such as Lake Winnipesaukee and its contiguous area that is comprised of hydrologically diverse elements must be analyzed for the Probable Maximum Flood by the rationale of their individual hydrologic response characteristics. To accomplish this, the subject catchment was separated into the lake area, 73 sq. mi., and the peripheral contiguous area, 290 sq. mi. The hydrologic response criteria for separation were direct rainfall on the lake area and a typical overland flow runoff pattern for the remaining area.

PROBABLE MAXIMUM PRECIPITATION: (PMP)

The joint U. S. Corps of Engineers - U. S. Weather Bureau Hydrometeorological Report #33 indicated a 200 sq. mi. - 24 hour "all season envelope" value of 18 inches for the project locus. This value was adjusted downward by about 8 percent to 16.5 inches as a trajectory correction for storm centering on the catchment. Both the total cachment area and type of storm assumed, indicated that a forty-eight hour storm would be typical for the extreme event.

To compute the depth-area-duration (DAD) values to be used in this study, the DAD values shown in Plate E-III from the Corps of Engineers for the storm of 2-4 November 1927 were utilized. Semi-logarithmic plots of the ratio of these historic values to the historic 200 sq. mi. - 24 hour value were made (see table E-1) and the ratios for the 73 sq. mi, and the total catchment of 363 sq. mi. were obtained. It was assumed that the PMP isohyetal pattern would be superimposed on the catchment so that both the total area, 363 sq. mi. and the lake area, 73 sq. mi., would experience their respective theoretical Probable Maximum Precipitation. This assumption permitted the computation of the PMP values for the various durations from a volume basis i.e. the PMP volume for a particular interval for 363 sq. mi. minus the 73 sq. mi. PMP volume divided by the remaining area, 290 sq. mi. would give the PMP value for that interval for 290 sq. mi. The derived PMP values are shown in Table E-2.

A smoothed cumulative rainfall curve with percent of total storm time versus percent of total PMP was used to derive two hour incremental and critically arrayed PMP values for both the 73 sq. mi. and 290 sq. mi. sub areas. To these values for the 290 sq. mi. were applied an assumed initial loss of 0.5 inches and a loss rate up through the 30th hour of 0.1 inches per hour for a total runoff of 13.6 inches. The two hour Probable Maximum Rainfall excess values are shown in Table E-3. The two hour incremental Probable Maximum Precipitation values for the Lake Area, 73 sq. mi., are also shown in Table E-3.

UNIT HYDROGRAPH DERIVATION:

The continuous drainage area of 290 sq. mi. is essentially elliptical and is drained by many radial streams. There are no stream gages for flow measurement on any of these streams, a fact which necessitated the use of the U. S. Soil Conservation Service's Triangular Unit Hydrograph Methodology. To accomplish this derivation, the major and minor axes of the enveloping ellipse were drawn and the hydrograph parameters of area, i.e., average elevation, length of longest water course and rim elevation were measured. Triangular Unit hydrographs which produced one inch of runoff from two hours of rainfall excess were then computed for each of the four sub areas.

Each of these triangular unit hydrographs were then ratioed up to a triangular unit by hydrograph for 290 sq. mi. with the peak being increased as the square root of the ratio of the drainage areas. These four new triangular hydrographs for 290 sq. mi. were plotted and a composite unit hydrograph derived on the basis of the critical time to peak. This derived 290 sq. mi. triangular hydrograph was then normalized to a conventionally shaped unit hydrograph using standard ratios of times and discharges. The ordinates of this normalized hydrograph are given in Table E-4.

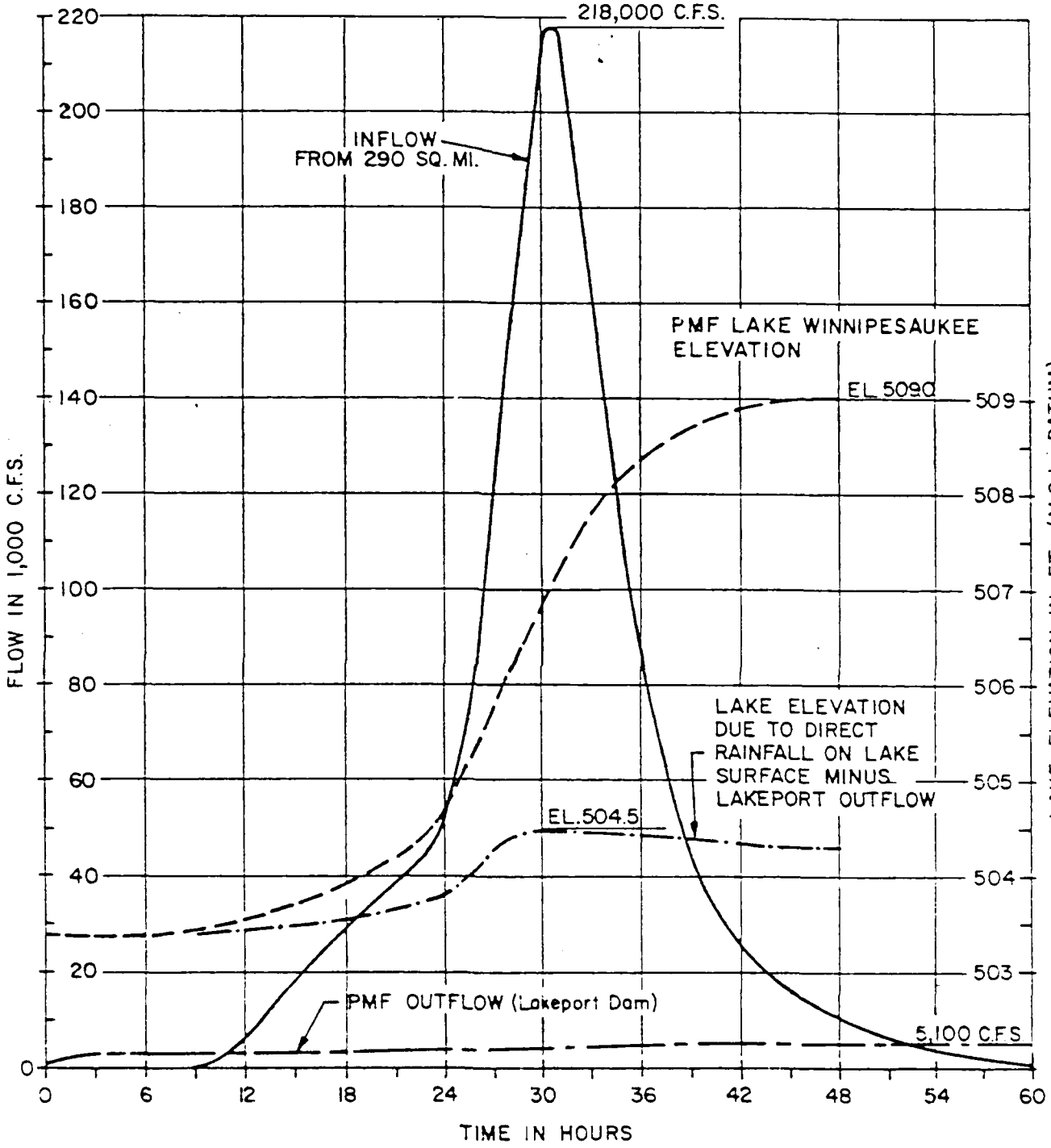
PMP INFLOW FLOOD HYDROGRAPH:

The rainfall excess values computed for the 290 sq. mi. area were then combined in a time-discrete method with the derived 290 sq. mi. unit hydrograph to produce the Probable Maximum Flood Inflow hydrograph from the contiguous area. This hydrograph had a peak of 218,000 cfs and a total runoff volume of 13.6 inches. See Plate E-1. As is customary in hydrologic studies of this nature, MAIN customarily performs routine checking procedures. The Nuclear Regulatory Commission has published a series of Probable Maximum Flood Peak Isopleths for various size drainage areas. Using curve fitting procedures, the PMF peak for 290 sq. mi. was found to be 198,500 cfs and had a Creager C of 87.7. This peak value is about 91 percent of the peak computed by MAIN and can be considered a check. The Creager C computed by MAIN was 96.8 which is a very reasonable value for an event of this rarity and severity. It must be noted that these checks are only for order of magnitude.

This PMF flood hydrograph was then combined with the temporal PMP values for the lake area to produce a time discrete volume curve for the lake for routing purposes.

Backwater curve analysis by Anderson-Nichols, consulting engineers of Concord, New Hampshire, indicated a four (4) ft. drop of water level from Lake Winnipesaukee to Lakeport Dam for a discharge of 5200 cfs and water level El. 505.3 at the dam. We used that result to obtain a 3.8 ft. drop to Lakeport Dam for the Lake Winnipesaukee PMF maximum water level of El. 509.0. PMF discharge at Lakeport Dam has 5100 cfs. (See Plate E-1).

Since the all season PMP envelope was the September value, a month end lake level duration curve for the lake was computed. The end of August lake volume, equaled or exceeded 25 percent of the time, was selected as a stringent value for this rare event. This value resulted in a starting elevation of 503.56.



NEW HAMPSHIRE WATER RESOURCES BOARD

CONCORD, NEW HAMPSHIRE

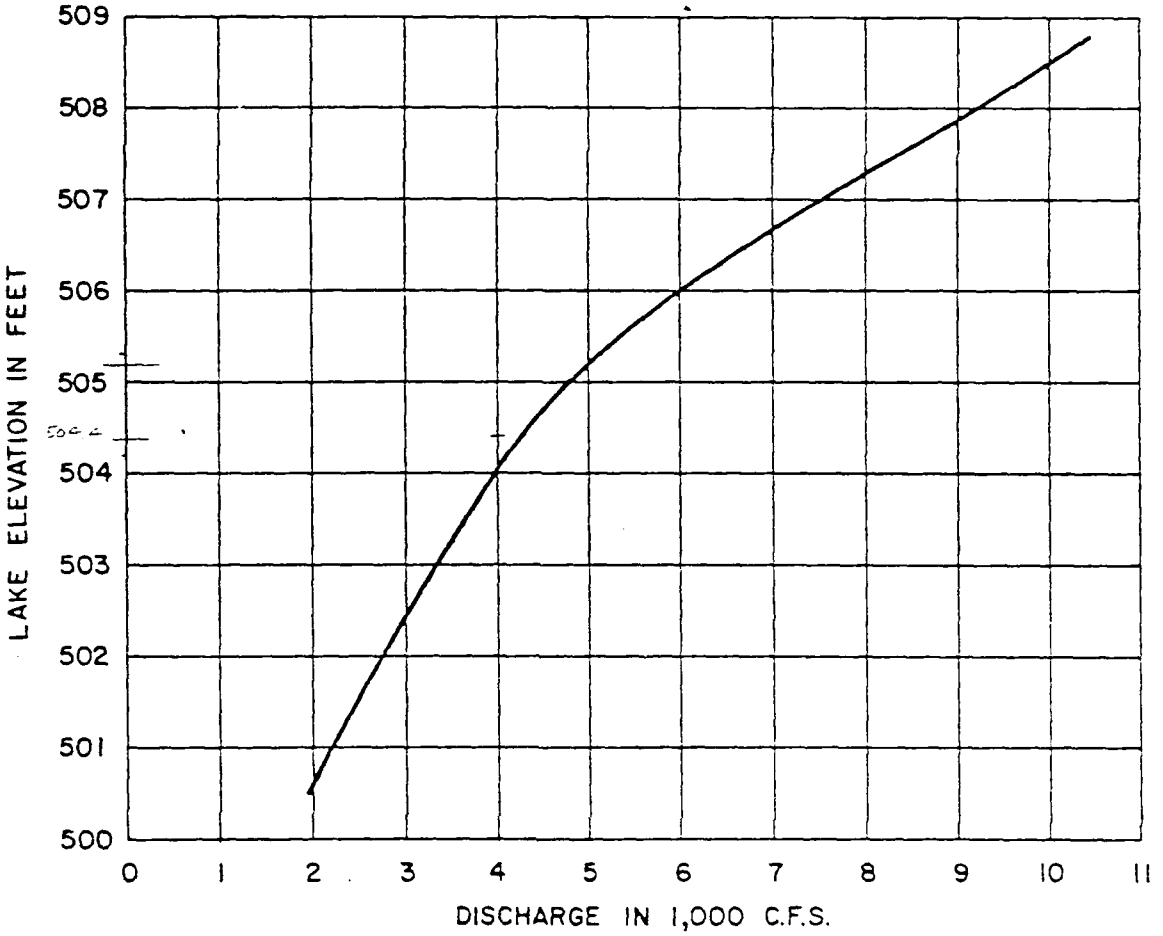
LAKEPORT DAM

HYDROGRAPHS
PROBABLE MAXIMUM FLOOD ROUTING

MAIN

DATE JULY, 1978

CLIENT	JOB	PLA
1318	12	E-I



NOTE: DISCHARGE BELOW EL. 504.2 IS FULL CAPACITY OF 3 GATES.

DISCHARGE ABOVE EL. 504.2 IS FULL CAPACITY OF 3 GATES PLUS FLOW OVER DAM.

NEW HAMPSHIRE WATER RESOURCES BOARD
CONCORD, NEW HAMPSHIRE
LAKEPORT DAM

PROJECT DISCHARGE CURVE

MAIN

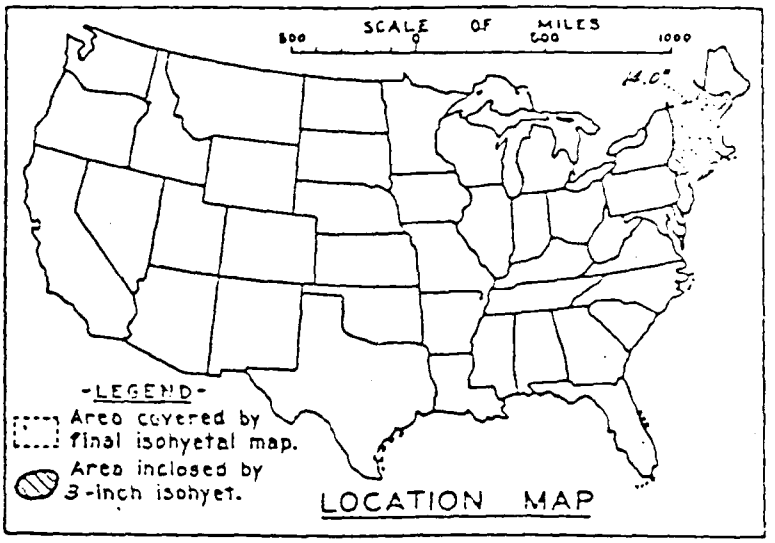
DATE DEC. 1977

CLIENT	JOB	PLATE
1318	12	E-II

D-14

DEPARTMENT OF THE ARMY — CORPS OF ENG

STORM STUDIES - PERTINENT DATA SHEET



LOCATION MAP

Storm of 2-4 November 1927
Assignment NA 1-17
Location Maine to Pennsylva
Study Prepared by:
North Atlantic Division
New York District Office

Part I Reviewed by H. M. Se
Weather Bureau, 2/11/46
Part II Approved by Office, Ch
of Engineers for Distribut
of Factual Data, 10/19/48
Remarks: Center at
Kinsman Notch, N. H.
Dewpt. 50°- Ref. Pt. 250 SS
Grid C-3

DATA AND COMPUTATIONS COMPILED

PART I

Preliminary isohyetal map, in 2 sheet , scale 1: 1,000,000

Precipitation data and mass curves: (Number of Sheets

Form 5001-C (Hourly precip. data)	1
Form 5001-B (24-hour " ")	523
Form 5001-D (" " " ")	4
Miscl. precip. records, meteorological data, etc.	1
Form 5002 (Mass rainfall curves)	90

PART II

Final isohyetal maps, in 2 sheet , scale 1:1,000,000

Data and computation sheets:

Form S-10 (Data from mass rainfall curves)	12
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Maximum duration-depth-area curves	1
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MAXIMUM AVERAGE DEPTH OF RAINFALL IN INCHES

Area in Sq. Mi.	Duration of Rainfall in Hours							
	6	12	18	24	30	36	48	60
10	7.8	10.6	11.7	12.0	12.8	13.7	14.0	14.0
100	5.8	8.3	8.8	9.2	9.5	10.1	10.3	10.3
200	5.7	8.2	8.6	8.8	9.0	10.0	10.2	10.2
500	5.5	7.9	8.2	8.3	8.5	9.0	9.2	9.2
1,000	4.8	7.3	7.7	7.8	8.2	8.8	8.9	8.9
2,000	4.0	6.4	7.0	7.3	7.9	8.1	8.2	8.2
5,000	2.7	4.8	6.1	6.7	7.2	7.7	7.9	7.9
10,000	2.3	4.0	5.5	6.3	6.7	7.0	7.3	7.3
20,000	2.0	3.5	4.7	5.3	5.8	6.2	6.4	6.4
50,000	1.6	2.8	3.6	4.1	4.5	4.9	5.1	5.1
60,000	1.4	2.5	3.3	3.8	4.2	4.6	4.8	4.8

Form S-2

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS